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Technology Department

ON THE COVER

IN SOME parts of the Edwards Plateau in West Texas water has at times sold for as much as ten cents a gallon and geophysicists using it for drilling shot holes have had to haul it long distances. For the lack of it their rigs have occasionally been shut down half the time. Conditions such as these have stimulated experiments with compressed air as a substitute for water or mud in bringing drill cuttings to the surface. Under some circumstances air has definite advantages, and its greater use seems to be assured. Details of the new technique are given in the article starting Page 11.

IN THIS ISSUE

TO MEET the demand for explosives during World War I, Hercules Powder Company expanded its operations greatly. Rather than retrench when hostilities ended, it sought and found new lines of endeavor in the chemical field. This search embarked the concern on a program of scientific investigation that has become indispensable to its growth and prosperity. Today, as our leading article explains, the Hercules research center employs 600 persons and spends more than $4,000,000 annually.

●

A TURBOCOMPRESSOR can produce more compressed air per pound and per cubic foot of space occupied than any other type of machine. But as it is essentially a large-capacity unit and comparatively expensive, it is usually restricted to certain fields of service. These are continually enlarging, however, and are more extensive than they are generally thought to be. The article beginning on Page 7 traces the development of the turbo in this country and points out its major applications.

●

THROUGH the centuries, Nature has established a delicate balance among all forms of life. In this scheme, enemies are created to hold undesirable members in check and to prevent them from overrunning the universe. Man is just beginning to utilize the natural policemen in the realm of microörganisms to combat germs that are responsible for human diseases. Typhus and kindred affections are now yielding to the antibiotic chloromycetin. How this mold growth was discovered and is now turned out are related in the article starting on Page 14.

●

JUST twenty-five years ago paint-spray outfits began to replace brushes on certain kinds of coating jobs and their field of service has grown markedly since that time. Now brushes are staging somewhat of a comeback, thanks to pressure feeding; and rollers, some also pressure-fed, have come along to do a share of the work. Page 18.

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EDITORIAL CONTENTS

Research Leads the Way at Hercules—*C. H. Vivian* 2
Development of Centrifugal Compressors—
C. T. Chapman and W. L. Luther 7
Compressed Air Aids Oil-field Prospectors—*Pierce Shannon* 11
Life-saving Chloromycetin—*A. M. Brodine* 14
Pressure-fed Paint Brushes and Rollers—*John Starr* 18
Editorials—Man-made Rain—Winter Driving Hazards 20
This and That 21
Air-powered Tubing Slips for Oil Wells 22
Well, Well — the Low Well is at Lowell 22
Industrial Notes 23
Books and Industrial Literature 28

ADVERTISING INDEX

Adams Co., Inc., R. P. 20
Allis, Louis, Company, The 11
Bethlehem Steel Company 8, 31
Cook Mfg. Co., Inc., C. Lee 29
Coppus Engineering Corp. 2nd Cover
Crucible Steel Co. of America 28
Dollinger Corporation 3
Eimco Corporation, The 9
Fluor Corporation, Ltd., The 5
Hanna Engineering Works 21
Hansen Mfg. Co., The 7
Hercules Powder Company 6
Ingersoll-Rand Company . 4, 19, 24 .. 3rd Cover
Ledeen Mfg. Company 17
Maxim Silencer Co., The 30
Naylor Pipe Company 14
New Jersey Meter Company 13
Niagara Blower Company 15
Norton Company 12
Nugent & Co., Inc., Wm. W 30
Sauerman Bros., Inc 27
Selas Corporation of America 22
Square D Company 27
Terry Steam Turbine Company .. 25
Texas Company, The .. Back Cover
Timken Roller Bearing Co., The .. 10
Toledo Pipe Threading Machine Co., The 23
Victaulic Company of America 16
Vogt Machine Company, Henry .. 18
Walworth Company 26
Wisconsin Motor Corporation 27

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Research Leads the Way at Hercules

A Firm Founded on Explosives Now Makes Chemicals for Many Industries

C. H. Vivian

WHEN the Hercules Powder Company began operating in 1912 it was, as the name implies, strictly a manufacturer of explosives. While it is still one of the nation's largest makers of powder and allied products, its name has become somewhat misleading because explosives no longer rank first, in point of revenue returned, among the things it now turns out. The major proportion of its sales, which are running around $140,000,000 a year, is accounted for by a long and growing list of chemical raw materials for various industries.

Hercules is, for example, one of the biggest suppliers of chemicals used in making paper. It is also among the world's foremost manufacturers of chemical cotton, the basic raw material for synthetic fibers, notably rayon. Other Hercules products enter importantly into protective coatings such as lacquers, into plastics, printing inks, insecticides, and textiles. Still others are essential in the extraction of metals from their ores by the flotation process. Few, in fact scarcely any, of the chemical materials the company makes can be classed as consumers' goods; that is, they do not satisfy the wants of people as they are. Instead, they are used by other manufacturers and processors in turning out myriads of end products.

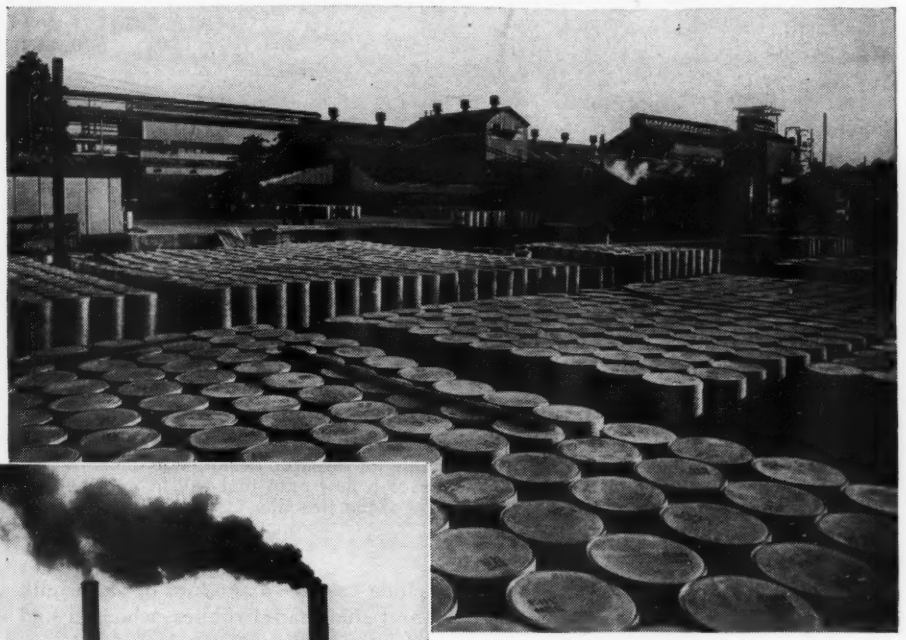
Like all concerns that make chemical materials, Hercules relies heavily on research to keep or to advance its competitive place in the branches it serves. Around three cents out of every dollar it takes in is set aside for this purpose. Charles A. Higgins, Hercules president and board chairman, refers to the research dollar as money spent to find new applications for existing products, to better them, and to discover new products in its particular fields. The locus of these research endeavors is a 40-building central laboratory and experimental station situated on 38 acres of scenic rolling countryside a few miles out of Wilmington, Del., where the company has its principal offices but no factories. In this pastoral setting, flanked on two sides by the fairways of the Hercules Country Club golf course, a staff of 600 seeks and often finds the answers to innumerable scientific questions. Among the personnel are 250 technicians, all with at least one college degree and many with the Ph. D. that is the hallmark of the research profession. Smaller laboratories at ten of the 32 manufacturing plants supplement the work of the central facilities.

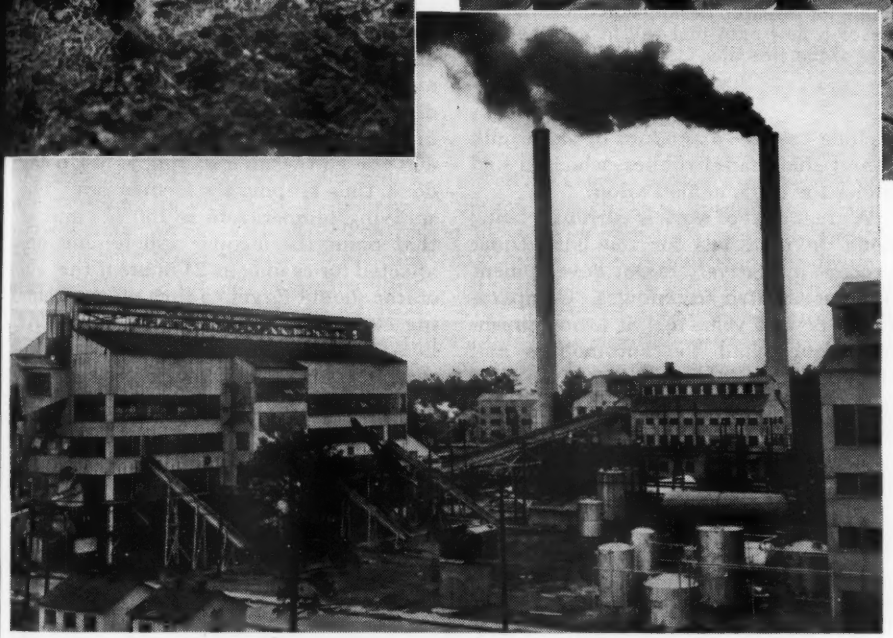
Hercules discovered the need of a research program early in its corporate life. To meet World War I orders for military explosives in 1915, it increased the capacity of its smokeless powder plant at Kenvil, N. J., from 50,000 pounds a month to 150,000 pounds a day and acquired the facilities of the Union Powder Company at Parlin, N.J. At that time Great Britain needed more cordite than she could make and was using the entire available supply of the essential solvent acetone in her own establishments. To get into cordite production, Hercules and U.S. Industrial Alcohol Company designed and built a plant at Curtis Bay, Md., for the manufacture of acetone from acetic acid made by the fermentation of alcohol.

Shortly afterwards, when it was learned that acetone could be obtained by processing giant kelp found along the Pacific Coast, Hercules erected a plant for that purpose at San Diego, Calif. As a result of those steps, Hercules alone reached a monthly production of 1,900,000 pounds of acetone, although the greatest prewar output in the entire country had been but 500,000 pounds. In addition to acetone and other solvents, that plant turned out enough potash to make all the black

STUMP RECLAMATION

What one industry discards another turns to profit. From the stumps and roots of southern pine trees cut down by papermakers Hercules reclaims rosin, terpenes, and oil. After being uprooted by pushdozers (left), the stumps are loaded for transport to processing plants at Hattiesburg, Miss., (bottom picture) and Brunswick, Ga., (below). As Hercules benefits, so do farmers, for the stump-removal program annually adds approximately a million acres of arable land to the nation's total.





powder needed by our Army. It was dismantled in 1920, but it had served as a valuable training ground in organic chemistry for Hercules personnel, and the knowledge gained there was put to good use when the company expanded its operations.

The end of the war brought a sharp drop in the demand for explosives, and in an effort to provide employment for its enlarged force of workers, the organization formed an industrial research department to look into other products that it could manufacture. The investigators decided that naval stores of various kinds could be obtained by recovering and processing the resinous matter in the stumps and roots of southern longleaf pines cut down by loggers. From that initial departure from the explosives field has grown one of the company's leading endeavors in the chemical field.

To get the rosins and terpenes from these tree stumps Hercules uproots them from cutover areas and, in so doing, makes approximately 1,000,000 acres of land available for agriculture each year. At Hattiesburg, Miss., and Brunswick, Ga., the wood is reduced to chips that are steam-distilled to extract the wanted resins. The residue chips are burned under boilers to generate the steam. Previously, rosin and turpentine had been produced from living pines by other processors, but the venture yielded a new industrial product—pine oil—which has meanwhile become a flotation agent widely used in the milling of ores.

Only stumps of first-growth trees can be treated economically. They contain about 25 percent of recoverable rosins and terpenes, while those of second-growth pines yield only around 10 percent. Consequently, the time is in sight when there may be a shortage of desirable raw material in the South. To meet this situation, Hercules has already turned westward. A pilot plant at Klamath Falls, Oreg., is now engaged in testing the possibility of processing stumps of Pacific Coast trees.

Another objective of the initial research program was the development of peacetime uses for nitrocellulose, which had been made in great quantities at Parlin as an ingredient for World War I explosives. Before long, the laboratory men found ways to employ it in the production of photographic film, plastics, and, most important of all, in lacquers. These applications increased so rapidly that it soon became necessary to provide additional facilities for turning out nitrocellulose, 89 percent of which was going into nonexplosives by 1939. Lacquer manufacturers utilized about two million pounds of nitrocellulose in 1919, whereas Hercules alone sold more than 35 million pounds to them in 1946. For the purpose of producing its own supply of chemical cotton, basis of nitrocellulose products, Hercules purchased the Virginia Cellulose Company, of Hopewell, Va., in 1926. Chemical cotton is made from the fuzzy short fibers that remain on cotton seed after ginning has removed the long fibers. Today, this fuzz and rosin are the two main raw materials used by Hercules.

All these early expansion activities

HERCULES EXPERIMENT STATION

In a rural setting a few miles out of Wilmington, Del., 600 technicians avail themselves of the most modern equipment obtainable for research designed to improve existing products, extend their uses, and develop new ones that will fit into the company's manufacturing program. Fairways of the Hercules Country Club golf course are in the background.

necessitated considerable research, and it was conducted as the needs arose, but there was no clear-cut research program. It had become apparent to the management, however, that such a program was vital to the company's growth, and the decision to establish a central laboratory with an adequate staff was made in 1929. Ground was broken in that year and, by 1931, the nucleus of the present plant was in full operation. Since then the facilities and staff have been gradually improved and extended. Concurrently, annual expenditures for research steadily mounted: from $500,000 in 1933 to approximately $4,250,000 in 1950.

Hercules has six main production departments: for cellulose products, explosives, naval stores, papermakers' chemicals, synthetics, and for Virginia cellulose. Each is headed by a general manager, and five of them are members of the board of directors. The research department is similarly organized, with divisions corresponding to the chief manufacturing units. Although these divisions hew pretty close to the line and aim to make their efforts yield information that can be put to practical and profitable use relatively soon, there is also a vast amount of pure research in progress at all times. Things learned thereby may be applied in any division, but it may take years to determine their practical value, if they have any.

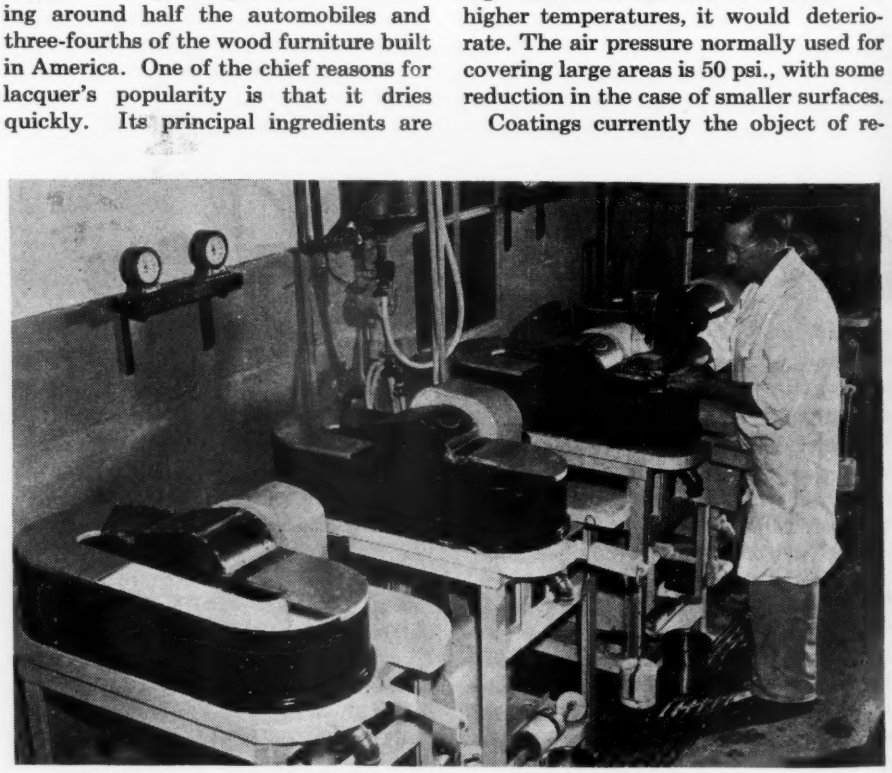
The materials made by Hercules for manufacturers of protective coatings represent its greatest single source of income, and a liberal share of the research work is consequently devoted to that group of products. They are derived mainly from rosin and cellulose, but also include casein—a product of skim milk—and chlorinated rubber, which is sold under the trade name Parlon.

A great deal of work is currently being done on materials for the hot-lacquer process, a relatively recent development of demonstrated advantages. Comparatively new 25 years ago, it is now finishing around half the automobiles and three-fourths of the wood furniture built in America. One of the chief reasons for lacquer's popularity is that it dries quickly. Its principal ingredients are resin, plasticizer, solvent, and nitrocellulose, with the latter serving as the film former.

Applying lacquer hot saves both material and labor. In compounding cold lacquer, about 3¾ pounds of solvent is required for each pound of nitrocellulose, while hot lacquer needs but 2½ pounds. This reduction in the quantity of solvent increases the concentration of the film former and improves the effectiveness of the finish. Thus two coats are sometimes as satisfactory as three coats of the cold lacquer, or one may replace two for certain purposes. The lacquer is applied by spraying, and the hot material can be broken up into finer particles than the cold by the air stream, with resultant better coverage. The operator can move the spray gun faster and cover a given surface quicker. In tests in a furniture factory, a cabinet of average size has been sprayed in 46 seconds.

Apparatus for heating the lacquer has been developed by a number of concerns. The type most used is a receptacle interposed in the air line between the source of lacquer and the gun. The heat is furnished by an electric element. A pump, driven by an air motor, recirculates the finishing material between the heater and the gun when spraying is not being done, thus keeping the lacquer hot. The spraying temperature is 160°F., and at that point the lacquer will remain unaffected for as long as 24 hours if the operator should forget to turn off the heating element at the end of a shift. At higher temperatures, it would deteriorate. The air pressure normally used for covering large areas is 50 psi., with some reduction in the case of smaller surfaces.

Coatings currently the object of re-



MINIATURE PAPER PLANT

To facilitate evaluating the numerous materials it supplies to the papermaking industry, Hercules produces pulps of various kinds on a laboratory scale and turns out handmade sheets of paper for test purposes. These machines are beaters that simulate the action of commercial-size units in a pulp mill.

search include finely divided cellulosics. These are reduced to a size of around 5 microns and then, in mixing them with a vehicle, are further ground to the 1- or 2-micron range in a pebble mill. They show promise of being useful in producing hydrosols of which thin films are applied to paper, aluminum foil, etc.

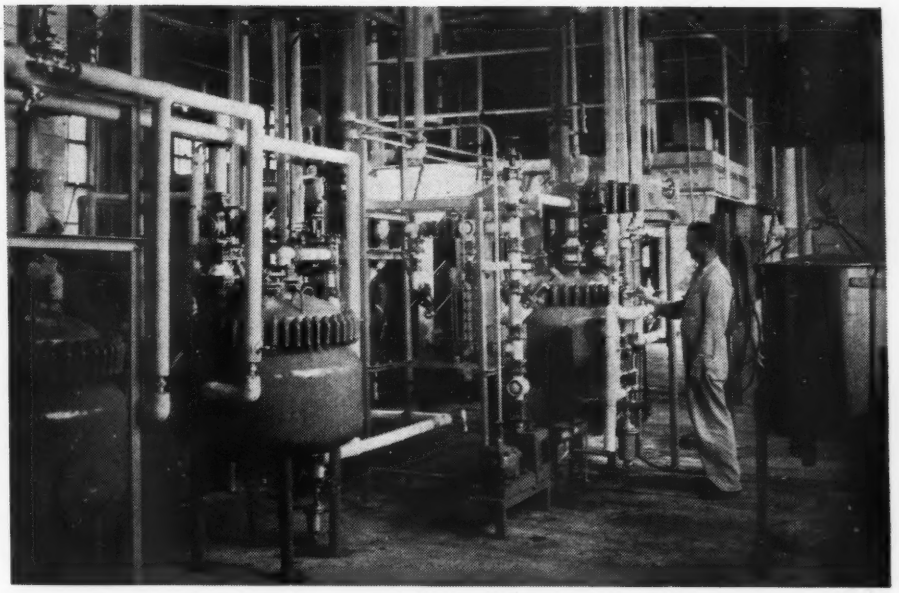
Because of the importance of papermaking chemicals in the Hercules sales picture, they naturally command much attention from the researchers. These materials, which enter into every phase of paper production, include rosin size, casein and satin white for coated papers, and various substances for the manufacture of special papers and for functional and decorative applications. In connection with the last-named group, it is of interest to note that as much nitrocellulose lacquer is consumed by papermakers as by the automobile industry.

Chemical cotton pulp is the base for cotton-content writing and blotting papers. Cotton rags were formerly used, but they have been largely supplanted in recent years because of their contaminating rayon and other synthetic fibers. Cellulose gum, which is marketed by Hercules under the designation CMC, strengthens paper, improves its finish, and increases its resistance to penetration by inks, waxes, and oils. The research laboratories include a miniature papermaking plant for experimenting with the company's products. There pulp is beaten and transformed into sheets on a hand press. Winding apparatus also is available for transferring commercial papers from roll to roll in applying coatings and sizings.

In addition to its products for the paper industry, Hercules makes basic materials such as nitrocellulose, rosin, and cellulose gum that enter into printing inks. Some impart quick-drying properties; others serve different purposes. Included are ingredients for inks suitable for printing on textiles, cellophane, and ceramics. Parlon goes into inks that resist alkalies and are used in printing on soap wrappers and kindred packaging materials.

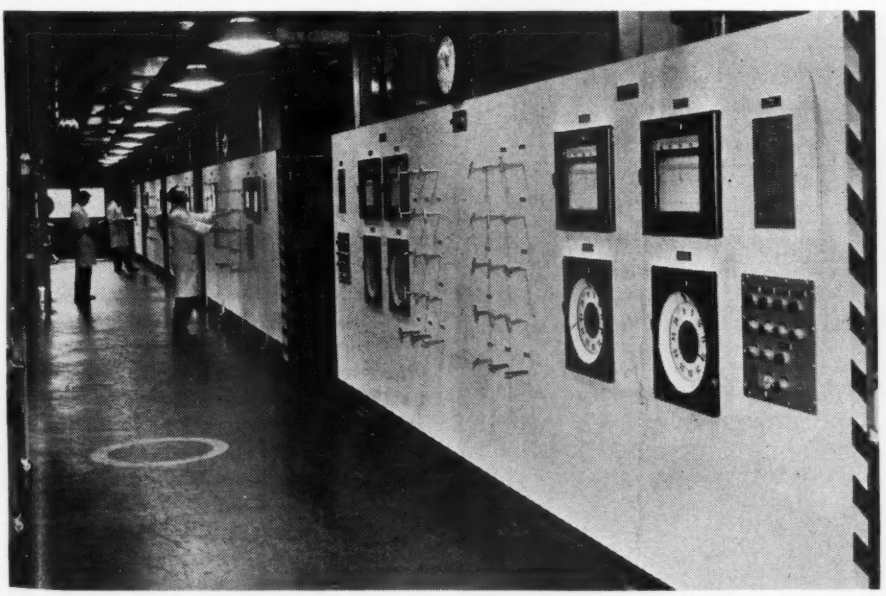
Hercules-produced cellulose derivatives have a wide field of application in molded plastics. Cellulose acetate is utilized, among other things, for making handles of kitchen utensils and Christmas-tree ornaments. Ethyl cellulose, known for its toughness, enters into such things as tool handles, heads of hammers employed in working soft metals, and inserts in the heads of golf clubs. It served extensively during the war in the manufacture of proximity fuses. Ethyl cellulose keeps its toughness at temperatures down to minus 100°F., which adapts it for numerous special purposes. In the laboratory, a standard test consists of dropping a 5-pound weight from a height of 3 feet on samples as many as twenty times. Another plastic material—casein—is converted into varicolored buttons, buckles, and ornaments.

One section of the laboratory is devoted to producing, playing, and testing phonograph records, both of the breakable and break-resistant kinds. The former have traditionally been made of shellac, together with whiting, slate flour, stearate, and carbon black. A Hercules-developed phenolic resin, trade-named Vinsol, can be substituted for the shellac when combined with Carnauba wax and ethyl cellulose, along with the conventional fillers. Vinsol is a complex substance that is probably related to lignin and has other applications. Its low price recommends it for use as the resin in dark-colored lacquer. In emulsion form it serves with other resins as a replacement and extender, especially as a rock-wool binder. Made into a soluble sodium soap it finds application as an emulsifier in slow-break asphalt emulsions and also



LARGE-SCALE-SAMPLES LABORATORY

In normal laboratory procedure, new or improved products are turned out in small quantities. In order to provide prospective customers with samples large enough for adequate testing, Hercules recently set up a completely integrated laboratory containing equipment that can be quickly adjusted to accommodate a wide variety of organic processes. Samples weighing from 10 to 1500 pounds have been made there.



HIGH-PRESSURE LABORATORY

Instruments on the panels control high-pressure experiments in autoclaves and continuous reactors that are safely located behind reinforced concrete walls to the right. Various gases are compressed to as high as 25,000 psi., for the reactions and temperatures up to 725°F. are utilized.

as an air-entrainment agent in cement. Whereas concrete mixed with ordinary sand and gravel weighs 150 pounds per cubic foot, that containing perlite and Vinsol weighs only 45-50 pounds and will float in water. Research indicates that Vinsol has probable uses as an ingredient in plaster and, possibly, in cement blocks, which are lighter than those of cinder aggregates. Plaster that has Vinsol in it resists slumping and is so light that large quantities of it can be handled and applied at a time.

Cellulose gum, or CMC, previously mentioned as a papermaking chemical, is much in the limelight right now as an ingredient in detergents for washing clothes. To be effective, a detergent not only has to remove the dirt but also prevent it from being redeposited. For instance, if grime is taken out of the collar and cuffs of a man's white shirt and is then disseminated throughout the body of the garment, the latter comes out gray instead of white. The particular function of CMC is to keep the dirt in suspension after it is removed and thus dispose of it. Hercules was the first concern to produce CMC on a commercial scale. Today it is added to some of the popular washing preparations on the market. CMC of high purity also enters into certain pharmaceuticals and cosmetics.

Another recent research activity concerns insecticides. An important Hercules contribution to this group of products is toxaphene (chlorinated camphene). Containing 67-69 percent chlorine, it is approved by Federal and State authorities for the control of insects that attack cotton plants, and is also effective against grasshoppers and other pests. It is applied either as a dust or a liquid.

Long established as a leading supplier of pine oil and other reagents used in the flotation of ores, Hercules is continually seeking new materials of this type, and has recently come up with one that is effective in upgrading Florida phosphate rock. Known as rosin amine D acetate, its particular function is to remove silica. Added to a flotation cell in the proportion of approximately 2/10 pound per ton of ore, it increases the percentage of bone phosphate of lime in the final product from 66-68 to 76-78. This has resulted in boosting the market price of the material from $3.75 to around $6.90 per ton.

In its original field of explosives, Hercules conducts research in buildings that are set apart from the other laboratory structures and are entered only by authorized persons. For making detailed studies of the mechanics of an explosion, the department has two notable high-speed cameras that were developed by Dr. Robert W. Cairns, assistant director of research. These machines photograph detonation waves that travel from 5 to 25 times as fast as sound. A "slow" explosion is one that lasts about one hundred-millionth of a second. A recent Hercules innovation in explosives accessories is the substitution of ethyl cellulose for the cotton insulation on blasting wire. Among its advantages are high resistance to abrasion, to which such wire is subjected in quarries and mines, and comparative immunity to the subzero temperatures often encountered in open-pit operations.

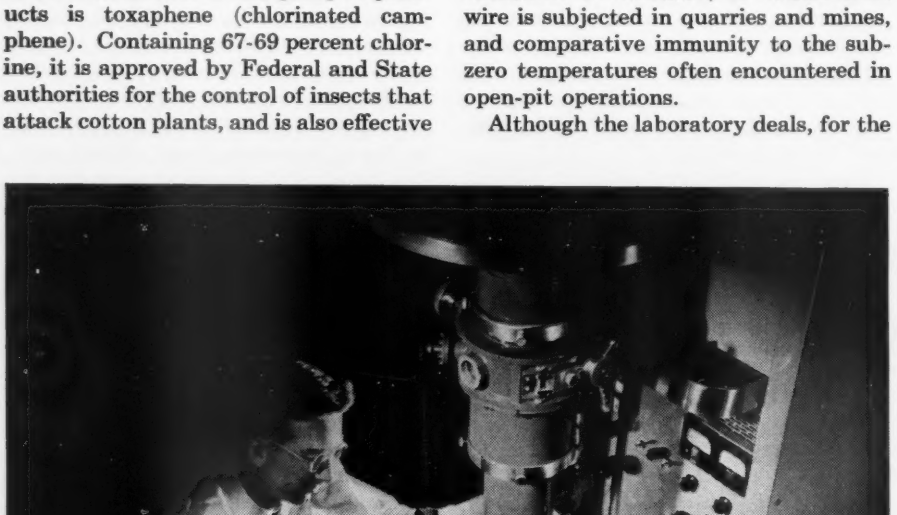
Although the laboratory deals, for the most part, with small quantities, a section has recently been put in service where samples are handled on a large scale. Its function is to furnish manufacturers with adequate amounts of newly developed materials to enable them to conduct their own tests and determine whether they can profitably utilize them in their products. The equipment is flexible enough to accommodate a wide variety of organic chemical processes with a minimum of changes. Work can be carried out at temperatures ranging from minus 75°C. to plus 400°C., and at pressures from 2 mm. to 100 psi.

To facilitate the study of high-pressure reactions, which are gaining in importance in the synthesis of chemicals, the Hercules experimental center includes a high-pressure laboratory. For safety reasons, it is several hundred yards from the main group of buildings and stands at the base of a steep hill. Three sides and the roof are of reinforced concrete, but the side toward the hill is of flimsy wood construction with wooden peg connectors so as to make sure that, in the event of an explosion, its force would be directed that way.

Experimental-size batch autoclaves and reactors are set up in individual cells, and all are provided with safety blowout disks that will yield if something goes wrong and dangerous pressures are built up. Controls are located in another room, behind a reinforced concrete wall. From the laboratory have come such products as a stabilized rosin of improved quality, rosin amines, and hydroabietyl alcohol. Most of the current work concerns rosin, and hydrogenation is of special interest. An addition now under construction will make it possible to conduct high-pressure reactions on a pilot-plant scale.

Various gases—including hydrogen, nitrogen, carbon dioxide, ammonia, and air—are placed under high pressures for test purposes, and facilities for handling and compressing them are an important part of the equipment. The gases are delivered at around 200 psi. in commercial steel bottles or cylinders, which are mounted in a rack outside the building and a short distance away. Overhead lines lead from the cylinders to the compression room. The main compressor is a 5-stage, electric-driven unit that discharges at a pressure of 10,000 psi. It has an intake capacity of 30 cfm. For still higher pressures—up to 20,000 psi.—a single-stage booster is available.

Aside from electricity, which is purchased, utilities for the main group of buildings come from an adjacent power plant, with all distribution lines underground. Steam is supplied for heating and process work, and compressed air at 100 psi. is delivered by two machines, one of which is turbine-driven. The air used in the laboratory serves chiefly to agitate solutions.



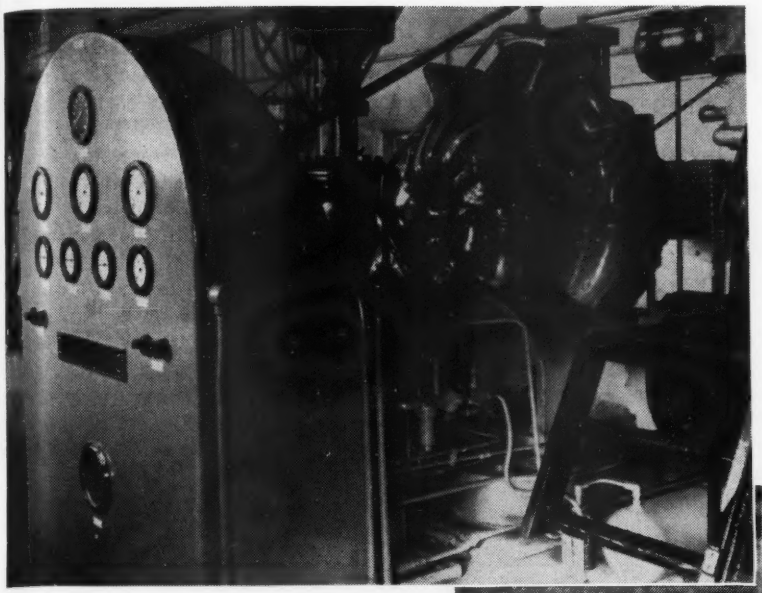
ELECTRON MICROSCOPE

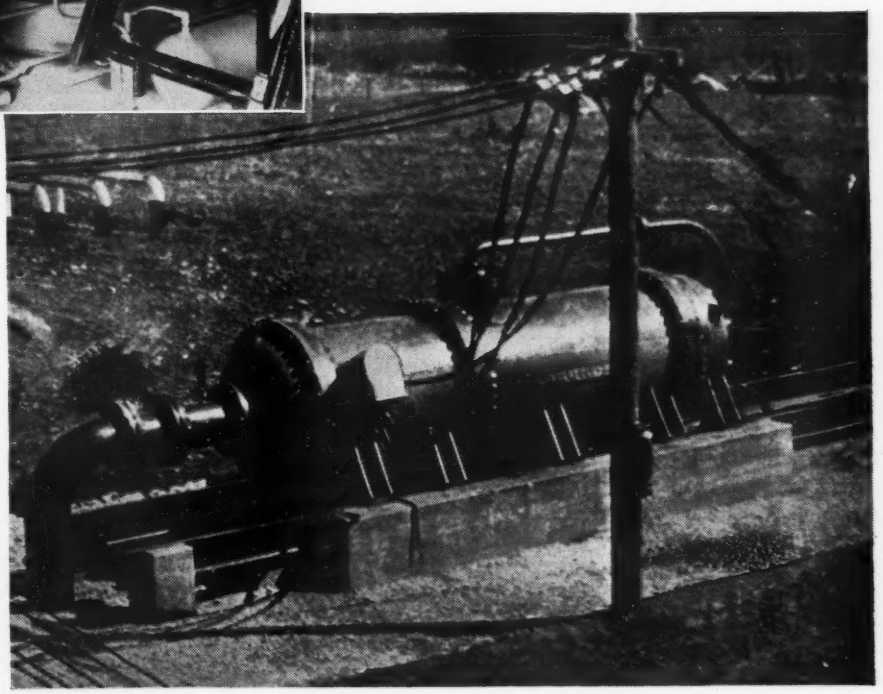
This highly useful research aid, manufactured by Radio Corporation of America, can magnify as much as 1000 times.

Development of Centrifugal Compressors*

Their Increasing Use Highlighted by Transmission of Natural Gas

C. T. Chapman and W. L. Luther





TRANSMITTING NATURAL GAS

In 1930, Ingersoll-Rand Company built a centrifugal compressor that was used experimentally by Cities Service Gas Company for boosting the pressure of natural gas being transmitted through a pipe line in Kansas. It was designed to handle 100 million cubic feet a day at the inlet and discharge it at 395 psi. pressure. The compressor and its 3000-hp. motor were contained in a pressure vessel incorporated in the line (above). Commercial transmission of natural gas by centrifugals was inaugurated in 1947 by Texas Eastern Transmission Corporation, using Ingersoll-Rand motor-driven machines discharging at 750 psi. pressure. Since then, 116 such units, 80 of them built by Ingersoll-Rand, have been placed in service on the system. They were built to fit on concrete foundations on which pumps rested when the lines, then known as the Big Inch and Little Big Inch, were operated by the Government as carriers of crude oil and gasoline during World War II. One of the centrifugals is shown in the upper picture.

THE centrifugal compressor has received widespread attention from the natural-gas, petroleum, and chemical industries during the past ten years, and this interest is continually widening its field of application. A review of the principal uses made of centrifugals since their introduction in this country 44 years ago will help to explain why they were adopted for some of their current spectacular services and also indicates their potentialities.

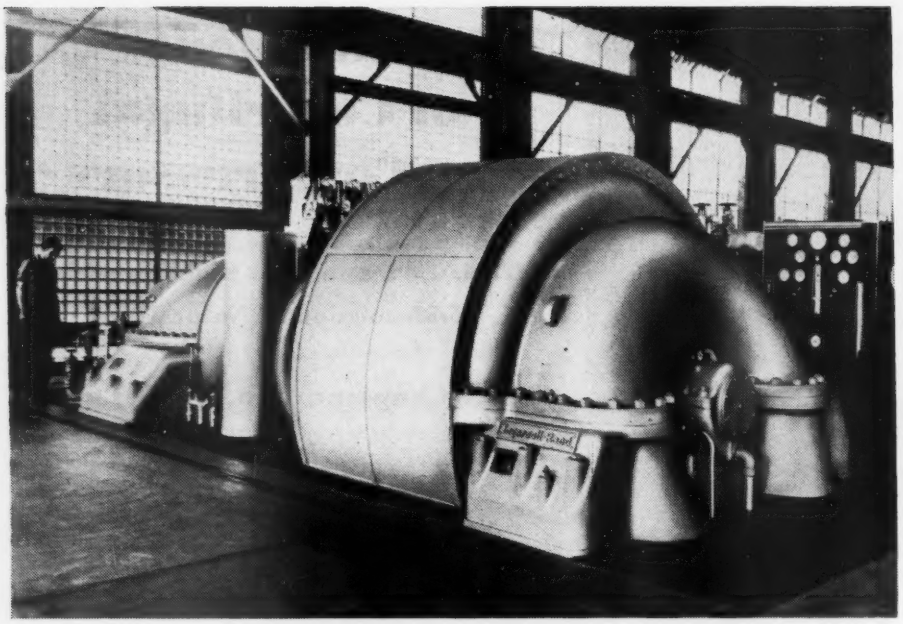
The first centrifugal blower or compressor built in the United States was a single-stage, low-pressure unit. It was turned out by General Electric Company in 1906 at about the time development work had been completed in Europe on centrifugal machines for compressing air to pressures up to 100 psi. Because it was manufacturing reciprocating compressors for the same operating range, Ingersoll-Rand Company became interested, and in 1912 built a 13-stage, water-cooled centrifugal unit with steam-turbine drive to compress 3500 cfm. of air to 100 psi. discharge pressure.

The construction cost and the operating figures showed that the centrifugal of small capacity had a limited field of application, which was determined largely by the type of driver, space and weight restrictions, and the necessity for oil-free air. Such a machine was unquestionably more expensive to make and needed more horsepower than a reciprocating compressor of corresponding capacity. Consequently, the reciprocating type continued to dominate, even though the centrifugal was much smaller and so well balanced as to greatly simplify foundation requirements. There was practically no demand at the time for large-capacity air and gas compressors.

Although the field of service for 100-psi. centrifugals was limited, it became apparent that machines of this type discharging at low pressures could meet various demands such as furnishing air for blast furnaces and Bessemer converters and for handling gas. Setting out to explore these possibilities, Ingersoll-Rand Company, in 1912, built the first blast-furnace blower in this country. It was designed to compress 55,000 cfm. of air from atmospheric pressure to 30 psi. discharge pressure and was driven by a 6350-hp. condensing steam turbine. Until that time all blast furnaces had been supplied with air by reciprocating compressors operated by either steam or gas engines. The savings the new type effected in floor and building space, foundations, and maintenance costs were soon apparent, with the result that centrifugals exclusively are now used for blast-furnace blowing. The original machine ran continuously until two or three years ago.

In 1915 a steam-driven centrifugal gas booster rated at 15,000 cfm. from zero inlet pressure to 13 psi. discharge pres-

*Adapted from a paper "Modern Trends in Application of Centrifugal Gas Compressors," presented to the Operating Section of the American Gas Association at the Production and Chemical Conference, New York City, May 22-24, 1950.



BLAST-FURNACE BLOWER

The first centrifugal compressor for blast-furnace blowing built in the United States was an Ingersoll-Rand unit that handled 55,000 cfm. of free air and discharged it at 30 psi. pressure. Since its appearance in 1912, the company has supplied all but a small fraction of the blast-furnace blowers used in American steel plants. The machine pictured compresses 100,000 cfm. of air to 30 psi. pressure and is driven by a 11,150-hp. condensing steam turbine.

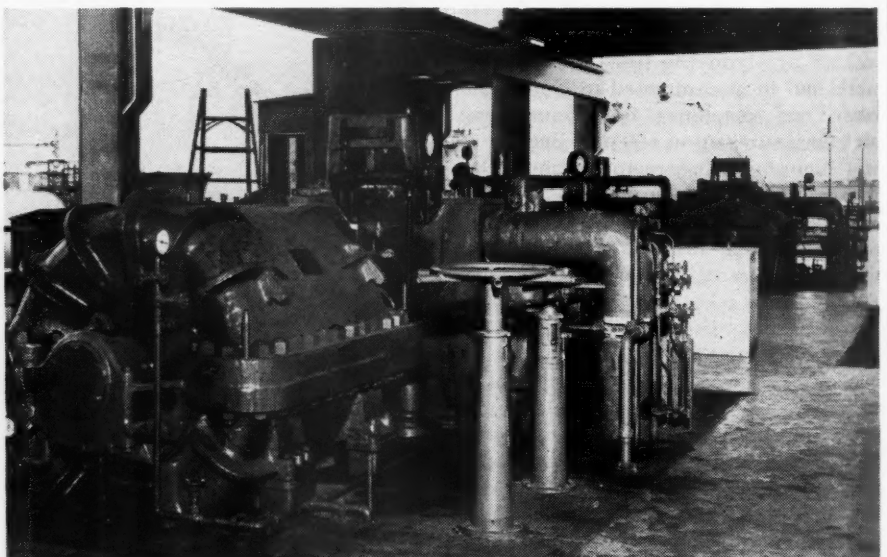
sure was placed in service. It demonstrated that centrifugal units could handle gas containing some dirt and having some corrosive properties provided proper safeguards were taken in designing them and in selecting the materials for them. Pressures involved and sealing to prevent leakage did not present problems of consequence.

As more centrifugals were successfully applied to low-pressure gas systems and more experience was gained, it was desired to try a machine of this type in a booster station of a high-pressure natural-gas transmission line where reciprocating units only had been employed. In 1930, Cities Service Gas Company purchased a centrifugal that had a rated inlet capacity of approximately 100 million cubic feet of gas per day and discharged it at 395 psi. The compressor proper, of multistage design, was mounted, together with its 3000-hp., 3575-rpm., electric motor, in a pressure vessel incorporated in the gas pipe line. Gas entered the vessel at one end, cooled the motor by flowing through it, passed through the compressor, and was discharged at one side of the vessel.

Because the machine was acquired for experimental purposes, it was installed at a point where operating conditions fluctuated from time to time. During a year of this sort of service, the compressor exceeded its expected performance. However, the gas load at the location chosen varied widely, and there were occasions when it dropped so low that there was no need to run the station. The standby costs, including the demand charge for power, were so high during those shutdown periods that it was considered uneconomical to put the compressor into permanent service.

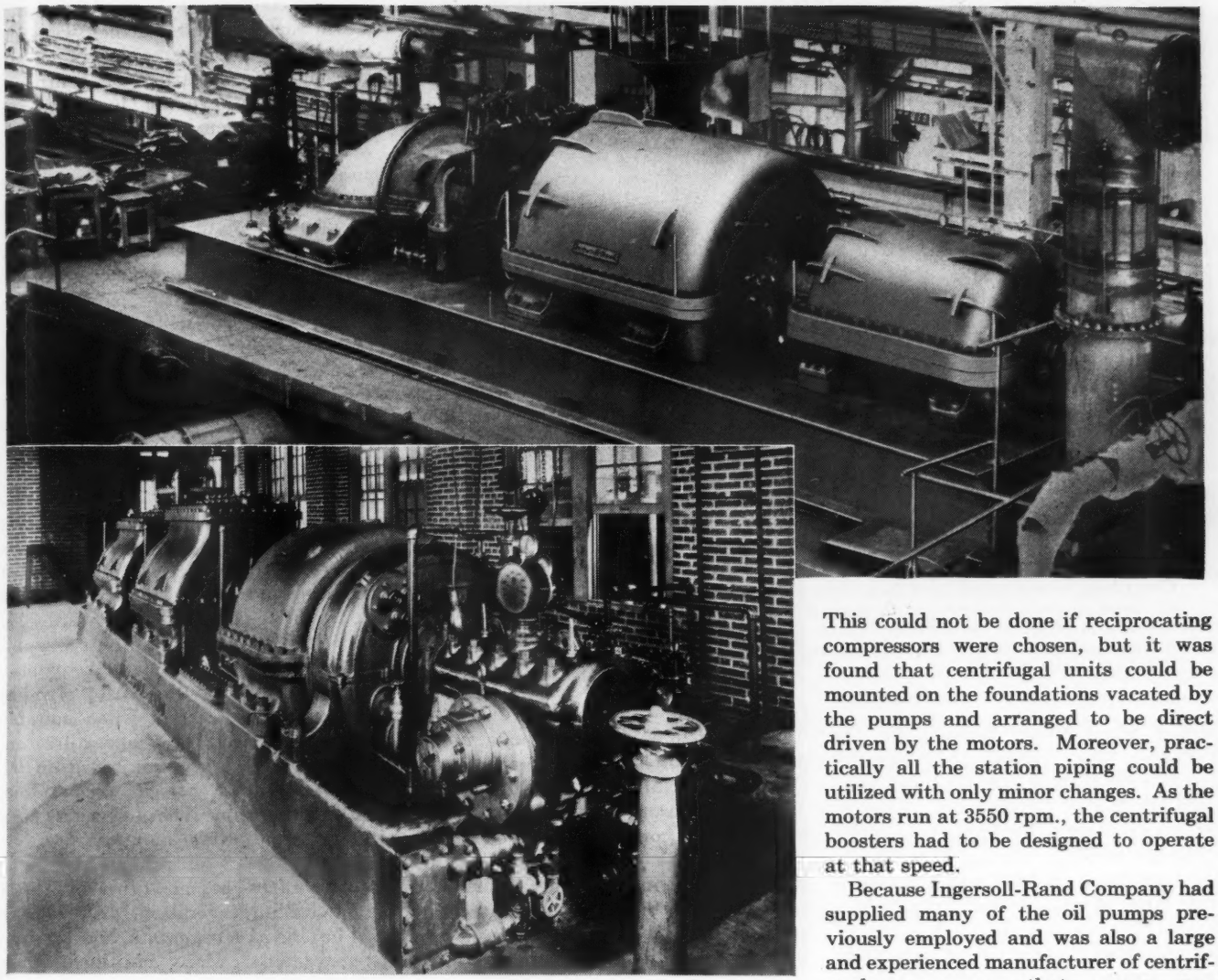
About three years later, the Syracuse (N. Y.) Lighting Company installed a turbine-driven centrifugal booster designed to send a mixture of natural and manufactured gas at 15 psi. through city distribution mains. The natural gas reached the station at a pressure of from 40 to 70 psi. and, in addition to its regular service, it was desired to use its energy as a power medium. The gas entered the centrifugal booster on the left side at the bottom of the casing, was admitted to an expander wheel by way of its periphery, and flowed out through the eye to mix with the manufactured gas, which was admitted on the right side, also at the bottom, and passed through four stages of compression. The admixture was discharged at 15 psi. pressure from the top-center of the casing. By means of adjustable vanes on both the compressor and expander it was possible to control the discharge pressure at any predetermined point. The Btu. value of the mixed gas was regulated by a caloric mixer which controlled a by-pass from the natural gas to the mixed gas.

In 1939 a centrifugal was built to recirculate flue gas at a temperature of about 750°F. in a refinery making toluene and high-octane gasoline. The unit had a rated inlet capacity of 12,070 cfm. and discharged at 125 psi. pressure. It was unique in design in that it took care of expansion resulting from the high temperature and provided a seal that would prevent outward leakage of the gas. Several refineries were afterward supplied



NEW USE IN FLUID-CATALYST CRACKING PLANT

Since the introduction in 1942 of the fluid catalytic process in petroleum refineries, compressed air at around 15 psi. pressure has been supplied by turboblowers for moving the powdered catalyst through a part of its circulation cycle. In the largest "cat" cracker so far constructed, a 41,000-barrel-per-day unit at the Bayway, N. J., refinery of Esso Standard Oil Company, two turbos are also performing a service that had previously been done only by reciprocating machines; that is, transferring gas originating in the cracker to a so-called "light-ends" unit after it has been initially treated in a fractionating tower. The gas is taken in at approximately ½ pound absolute pressure and compressed to 114.7 psi., gauge. Each turboblower has a capacity of 12,900 cfm. under these conditions, and is driven by a 2756-hp. condensing steam turbine. The use of centrifugal machines has reduced the size and cost of the installation and is expected to make for smoother control and better over-all plant operation.



HIGH-PRESSURE CENTRIFUGALS

The first American-built centrifugal machine for compressing air to 100 psi. was made by Ingersoll-Rand Company in 1912. The lower picture shows one of the pioneer units as it was installed in a manufacturing plant. Other early machines of similar design were placed aboard the U. S. battleships "Oklahoma" and "Nevada." A recent application of high-pressure centrifugals is in the production of oxygen on a tonnage basis. An Ingersoll-Rand machine for that service is pictured at the top while undergoing shop tests prior to delivery. It consists of two units (low-stage and high-stage) mounted on a common baseplate and driven by a 10,610-hp. steam turbine. The machine compresses 52,300 cfm. of air to 102 psi.

with similar machines for gas at a maximum temperature of 850° and at discharge pressures up to 300 psi.

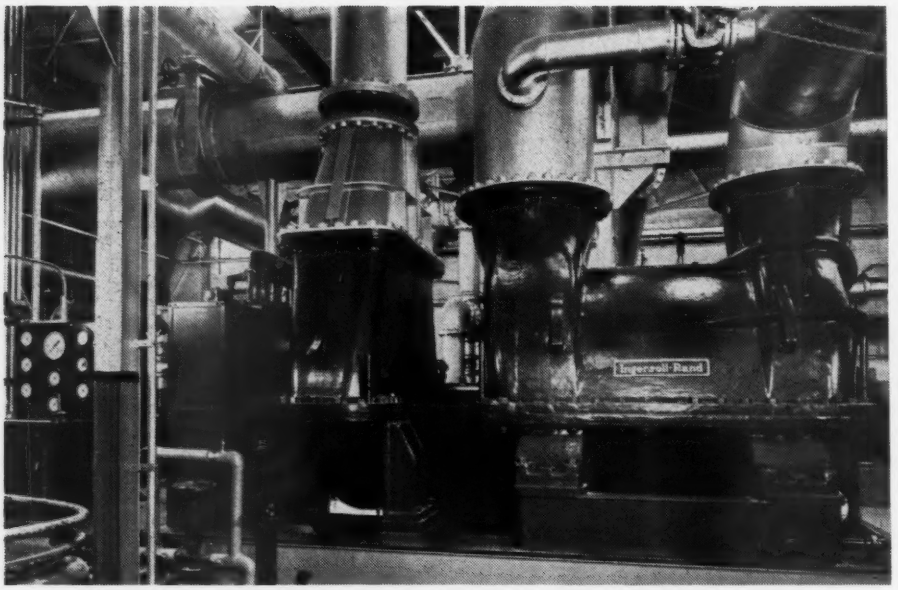
The first blower for handling air in a fluid-catalyst petroleum-cracking plant was introduced in 1940. Rated to discharge an intake of 24,000 cfm. of air at 25 psi., it was driven by a 3400-hp. condensing steam turbine. No new design or manufacturing problems were involved in its construction, but it created widespread interest among petroleum-refinery engineers because of the compactness of the centrifugal compressor. This particular unit was approximately 20 feet long and 9 feet wide.

This broad background of experience with centrifugal compressors, together with a thorough knowledge of their service requirements and limitations, has made it possible to use these machines in several other fields. One of the most spectacular of their recent applications is the transmission of natural gas through interstate pipe lines at high pressures. That was, of course, presaged by the pioneer efforts of the Cities Service Gas Company, which have already been mentioned.

When Texas Eastern Transmission Corporation took over from the Government the Big Inch and Little Inch pipe lines laid during the war to carry crude oil and gasoline and began to convert them into natural-gas lines, the conditions of its contract, plus the availability of certain equipment, indicated that time and money could be saved by installing centrifugal boosters. The centrifugal oil pumps previously in use were operated by electric motors, and it was desirable that the latter be retained. This could not be done if reciprocating compressors were chosen, but it was found that centrifugal units could be mounted on the foundations vacated by the pumps and arranged to be direct driven by the motors. Moreover, practically all the station piping could be utilized with only minor changes. As the motors run at 3550 rpm., the centrifugal boosters had to be designed to operate at that speed.

Because Ingersoll-Rand Company had supplied many of the oil pumps previously employed and was also a large and experienced manufacturer of centrifugal compressors, that concern was asked to quote on the gas boosters. The service requirements presented two problems in design and construction. One was to build a unit of the prescribed physical size suitable for 750 psi. discharge pressure; the other was to develop a seal that would effectually prevent that high-pressure gas from leaking out of the casing along the shaft passing through it. Neither was considered especially serious because the company had considerable background in designing and making pump casings for comparable or even higher pressures. Furthermore, it had already carried on extensive developmental work with seal testers. This experience, coupled with that gained in constructing hot-gas regenerators and blowers for gas-plant service, qualified the manufacturer to build the equipment with the same assurances and guarantees given for standard commercial centrifugal blowers and compressors.

The first unit was purchased from Ingersoll-Rand in the spring of 1947 and went into operation in the following November. Since that time, the company has furnished a total of 80 of these compressors (69 percent of the 116 in successful use on the Big and Little Inch lines). In addition, it has supplied three



FOR DISTRIBUTING CITY GAS

Centrifugal compressors have been successfully used since 1915 by gas utilities for sending their product out through distribution lines. The unit shown was recently installed in the Portrero Station of Pacific Gas & Electric Company. It has an intake capacity of 30,000 cfm. and discharges at 18 psi. It is driven by a 2395-hp. steam turbine.

similar motor-driven boosters for the Tennessee Gas Transmission Company and one gas-turbine unit for the Mississippi River Fuel Corporation. The latter, operated by a Westinghouse simple-cycle gas turbine, was put in service in the late spring of 1949 and ran over a wide range of pressure and capacity conditions to permit a thorough study of performance characteristics, operating requirements, and efficiency. Comprehensive data were accumulated and considerable knowledge gained as to the possibilities of this type of drive. At the time this paper was written the booster had just completed a 45-day run with no shutdown. Recently, Transcontinental Gas Pipe Line Corporation ordered two Ingersoll-Rand package-type machines, each consisting of a centrifugal booster direct driven by a steam turbine and mounted on a surface condensing plant —the entire assembly to be built by the supplier.

Selection of the type of drive for a centrifugal booster on a gas pipe line is an individual problem and depends upon local conditions. In most localities the cost of power prohibits the use of motors. Steam-turbine drive is definitely economically possible, especially where water is readily available. Gas-turbine drive has much to commend it, but it has yet to be proved whether it can be profitably installed and operated. In addition, there are some reservations as to cost of maintenance and availability for service.

Within the past 2½ years two centrifugal units, each operated by a 3470-hp., condensing steam turbine, have been installed in a natural-gasoline plant. Each is designed to handle 38,600 cfm. at the inlet and to discharge at 22 psi. pressure. The purpose of these machines is to boost the pressure of the gas taken in by reciprocating compressors driven by gas engines. Their use has brought about substantial savings not only in first but also in operating cost. Maintenance charges have been negligible, and the ease with which they function has appealed to the staff.

In 1949 two Ingersoll-Rand gas compressors in a fluid-catalyst cracking plant began to handle 12,900 cfm. of refinery gas at 15.2 psig. pressure and to boost it to 114.7 psig. They are driven by 2756-hp., noncondensing, high-back-pressure steam turbines. Before they were purchased, the refinery engineers made a thorough investigation of centrifugal compressors, including inspections of manufactured-gas plants where they were in use. It was found that the composition of the gas, including the presence of corrosive substances and dirt, was comparable in both cases. Successful operation has justified the engineers' judgment in selecting this type of equipment. At the time this paper was delivered the machines had been running continuously for nine months, and this was believed to be a record for units of their size. Reciprocating compressors had previously always been used for this particular gas-compression service at fluid-catalyst cracking plants.

More recently, a new refinery process called for a recirculator to handle gas at a temperature of around 500°F. and a pressure of 100 psi. It was essential that its seal should prevent not only outward leakage of the gas but also inward leakage of the sealing medium. It was discovered that the mechanical oil seal, which had been developed for pipe-line service, could be used when suitably modified to meet the temperature conditions involved. A unit based on the design of earlier hot-gas recirculators and incorporating such a seal has been in service for several months.

In recent years centrifugals have come into general use in many other fields such as industrial refrigeration, with propane and butane as refrigerants, and tonnage oxygen plants. Many additional applications will doubtless develop as manufacturers have more and more experience with these machines and as users, through increasing operating experience, acquire a better understanding of their limitations and characteristics.

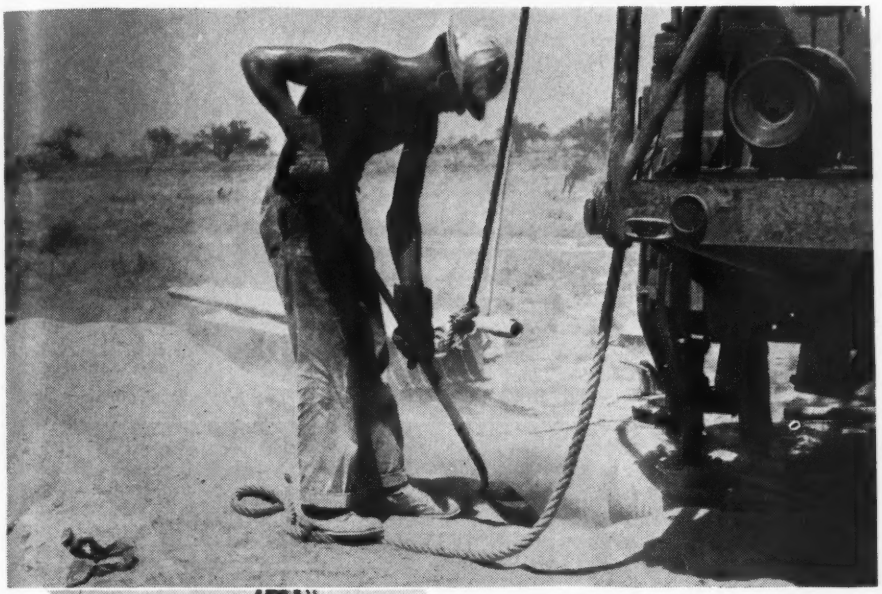
IN A NATURAL-GASOLINE PLANT

The two turboblowers shown were placed in service in 1948 in a natural-gasoline extraction plant where they compress 38,600 cfm. of casing-head gas from below atmospheric pressure to a discharge pressure of 22 psi. They deliver the gas to reciprocating compressors that boost it to higher pressures. Each blower is driven by a 3470-hp. condensing steam turbine.

Compressed Air Aids Oil-Field Prospectors

Pierce Shannon

Under Some Conditions It Excels Water or Mud for Removing Cuttings from Holes Drilled for Subsurface Blasts



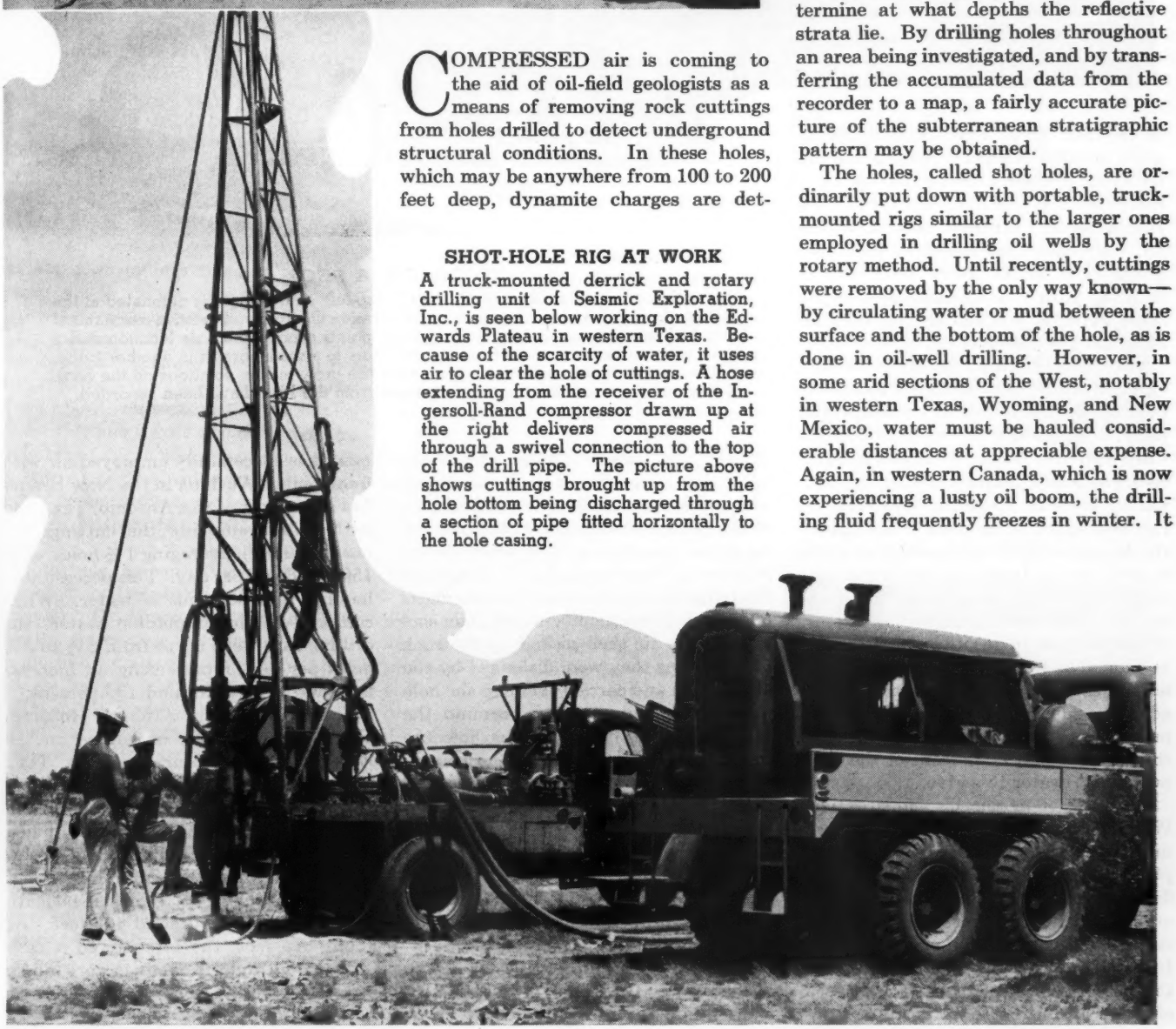
COMPRESSED air is coming to the aid of oil-field geologists as a means of removing rock cuttings from holes drilled to detect underground structural conditions. In these holes, which may be anywhere from 100 to 200 feet deep, dynamite charges are detonated so that seismograph crews can record the time it takes the concussion waves to travel through the earth. When a shot is fired, the waves radiate in all directions. Those projected downward will, upon striking a hard or dense formation, be reflected towards the surface.

Mechanical ears stationed at various points around the hole pick up the waves, which are then transmitted by wires to a central truck where they are converted into wavy lines on a seismograph tape. Because the speed at which they travel is known, the interpreters can determine at what depths the reflective strata lie. By drilling holes throughout an area being investigated, and by transferring the accumulated data from the recorder to a map, a fairly accurate picture of the subterranean stratigraphic pattern may be obtained.

The holes, called shot holes, are ordinarily put down with portable, truck-mounted rigs similar to the larger ones employed in drilling oil wells by the rotary method. Until recently, cuttings were removed by the only way known—by circulating water or mud between the surface and the bottom of the hole, as is done in oil-well drilling. However, in some arid sections of the West, notably in western Texas, Wyoming, and New Mexico, water must be hauled considerable distances at appreciable expense. Again, in western Canada, which is now experiencing a lusty oil boom, the drilling fluid frequently freezes in winter. It

SHOT-HOLE RIG AT WORK

A truck-mounted derrick and rotary drilling unit of Seismic Exploration, Inc., is seen below working on the Edwards Plateau in western Texas. Because of the scarcity of water, it uses air to clear the hole of cuttings. A hose extending from the receiver of the Ingersoll-Rand compressor drawn up at the right delivers compressed air through a swivel connection to the top of the drill pipe. The picture above shows cuttings brought up from the hole bottom being discharged through a section of pipe fitted horizontally to the hole casing.



RECORDING A SHOT

Dirt and stones are hurled high in the air, top-left, as dynamite is detonated at the bottom of a hole put down by Heiland Exploration Company. Sensitive mechanical ears had been set up previously at various points around the hole location and a truck (above) had laid wires from the detectors to a seismograph in another truck. Within the latter, top picture, a member of the crew makes notations on the back of the tape on which the concussion waves from the blast have been recorded.

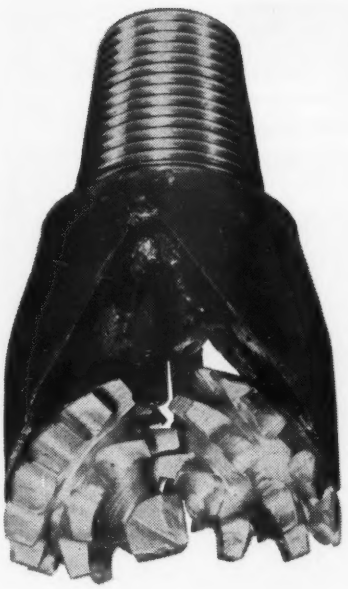
is in such areas that compressed air gives promise of solving operational and economic problems. Several geophysical concerns that conduct subsurface explorations on a contract basis, as well as oil companies that maintain their own geophysical staffs, have been experimenting with the air-blast method for some months, and the results thus far obtained are encouraging.

One pioneer in this research has been C. G. Walters, both while he was president of the Geotechnical Drilling Company, a subsidiary of the Geotechnical Corporation of Dallas, Tex., and more recently as head of his own concern. In computing costs of operating Geotechnical rigs last spring in western Texas, where the annual rainfall isn't enough to make a good dew in Louisiana, he found that the expense of procuring water for cleaning out holes was an important factor. At the location in question, water had to be hauled as far as 30 miles, and a fleet of trucks was unable to maintain an adequate supply. The cost per tankload ranged from $1 to $5, and the rigs were shut down about 60 percent of the time waiting for water to arrive.

In an effort to remedy the situation, Walters assigned one unit to experimenting with compressed air as a replacement for the conventional drilling fluid. With the help of representatives of equipment concerns, especially bit experts and compression engineers from Ingersoll-Rand Company, he outfitted the rig for test operation. Compressed air from an I-R 315-cfm. portable compressor was passed through the rotary hose that formerly carried the liquid and down through the hollow drill pipe to the rotary bit attached at the bottom. As an accompanying illustration shows, nozzles had been welded on to the bit to discharge the air across the cutting edges of the revolving members and thus cool them. The air then picked up the rock fragments as they were dislodged by the bit's action and carried them up the hole through the annular space around the drill pipe. At the top of the hole the cuttings were blown through a horizontal exhaust pipe. Although the compressor was capable of discharging at 125 psi. pressure, the drillers found that cuttings could be satisfactorily removed with pressures as low as 20 psi.

Since this initial experiment, various other operators have tried compressed air, and still others are preparing to investigate its possibilities. Most of the rigs have used 4½-inch bits and 2½-inch drill pipe. However, Shell Oil Company has successfully employed air with 6-inch bits. Working in the New Braunfels area north of San Antonio, Tex., and with water removing the cuttings, its crews had been averaging 1½ holes, each 150 feet deep, per day. This necessitated hauling 21 truckloads of water. When compressed air supplanted water, the drilling rate went up to from 2½ to 3½ holes per day, representing an increase in penetration of around 100 percent.

Seismic Exploration Inc., of Houston, Tex., put an air rig in service on the Edwards Plateau near Big Lake, Tex., last September, using 2⅜-inch drill pipe and a 4¾-inch Tricone rock bit having a 1-inch water course. Air was supplied by an I-R 315-cfm. portable compressor. A hole was drilled to a depth of 500 feet and was in limestone from just beneath the overburden to around 460 feet. At about 375 feet, the bit entered a cavernous zone and the cuttings were blown into underground openings for 10 or 15 minutes, after which they again began



ROTARY-DRILL BIT

A bit of this type is used for drilling in hard formations. The nozzle extending down on the near side and an opposed one that is visible through the opening direct compressed air across the cones to cool them while they are working and then to pick up the cuttings and carry them out of the hole.

to emerge at the surface. The bit was in blue clay from 465 feet to 490 feet, where a large flow of water was struck in a sandstone formation. This rose to the surface and, in conjunction with the air, flushed the hole clean, and no trouble was experienced in removing the drill string.

At the same time, Seismic Exploration had a rotary drill using water and a cable-tool unit working near by. For the first 110 feet the water rotary maintained about the same drilling speed as the air rig, but it lost circulation of the fluid at that depth and a new hole had to be started. The cable-tool unit encountered no difficulties, but was slow. It was estimated that it would have to work five 24-hour days to complete a 500-foot hole, as compared with two 9-hour days for the air rig.

Taylor Exploration Company, of Houston, is testing the new hole-cleaning method by alternately drilling holes with an air rig and a water rig in the Ballinger, Tex., area. During the month of August, the former put down 68 holes having a total footage of 8240, while the water rig drilled 43 holes, or 5270 feet. This figures out to a 56-percent greater penetration for the air rig. The formations varied from hard rock to wet clay and caliche, a local name for gravel and sand cemented by calcium carbonate. Layers of dry gravel were also encountered occasionally, and some zones were cavernous and therefore capable of causing trouble. Taylor has been getting comparable results with another air unit near Graham, Tex. Each is served by an I-R 315-cfm. portable compressor, which is mounted on pneumatic-tired wheels and is pulled behind the drill-rig truck when moving to new hole locations. In both instances an appreciable monetary saving is being effected.

In one West Texas section the Geotechnical Drilling Company successfully put down holes with an air unit after a water rig had failed. A crew made two attempts to drill a 150-foot hole near a dry creek bed. After ten hours, both holes were down 60 feet, but could not be carried farther and had to be abandoned. A ton of mud, half a ton of bran, five loads of water (which had to be hauled 15 miles), and two rock bits had gone into the effort. Two days later the air rig drilled a 150-foot hole between the two abandoned ones in 3½ hours, and upon its completion the bit was in such good condition that it was used to drill a second hole in the area.

From the work done, it is apparent that air is superior to water or mud under certain circumstances, but it cannot be considered as a cure-all for the difficulties that attend shot-hole drilling. The concensus is that air generally excels in dry formations and especially in cavernous rocks that permit water or mud to escape and, consequently, to break the circulating cycle. On the other hand, water or mud appears to be the better medium where small water seams are encountered and in many loose formations such as sand and gravel.

Drillers have found that longer bit life can be expected when cuttings are removed with air. This can be attributed in part at least to the fact that air is an excellent cooling agent and keeps the bit at a favorable operating temperature. Anyway, for some time to come, the use of air rigs will perhaps be limited to sections where the problem of obtaining water is serious or where trouble is experienced in maintaining normal liquid circulation. It seems to be a certainty that compressed air will gain preference in dry climates and where severe winter temperatures prevail.

Meanwhile, Walters, who has had as much experience with the departure as anyone else, believes that the most practical rig would be one equipped for either air or water. Either medium could then be used, as conditions may demand. It might even be possible to drill part of a hole wet and part of it dry.

In turning to air for the purpose discussed here, oil-field prospectors are, of course, merely adopting a method that has been successfully practiced by the rock-drilling industry for more than 50 years. The first practical air- or steam-driven drills, which appeared shortly after 1870 and were of the piston type, used solid drill rods, and one of their disadvantages was that they provided no effective way of removing cuttings as a hole was deepened.

In 1896, J. George Leyner introduced hollow steel as one feature of his revolutionary hammer-type drill and thereby made it possible to continually direct a stream of compressed air down the hole to clean away the rock fragments as they were broken off and whisk them to the surface. This enabled the bit to work always on a clean, solid rock surface instead of on a cushion of accumulated cuttings, and greatly increased drilling speed. Either air alone or a mixture of air and water (to allay dust) has been used ever since. The maximum drilling depth of these small machines is ordinarily around 30 or 40 feet. However, in the case of the new Quarrymaster, which was developed for putting down large-diameter blast holes in quarries, open-pit mines, etc., cuttings are readily removed by air alone from depths of as much as 70 feet. Rock drills are, of course, percussive machines, whereas we are considering rotary-action drills. However, the principle involved in the removal of the cuttings is the same in both cases.

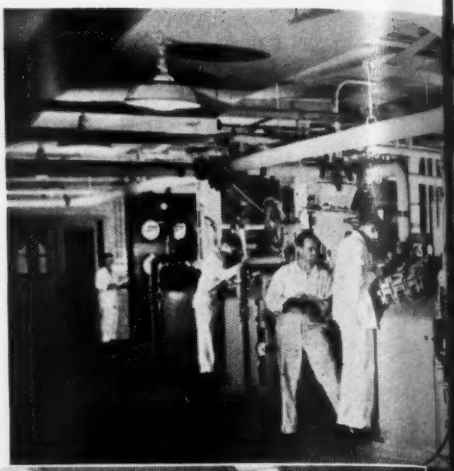
WHERE CUTTINGS EMERGE

Top– A guard fitted around the drill pipe protects the driller from flying particles. Center– Cuttings coming out of a hole being drilled by Shell Oil Company geophysicists. Bottom– One advantage of removing cuttings with air is that some are large enough for geological study. The pieces shown are from a hole in southern Texas.

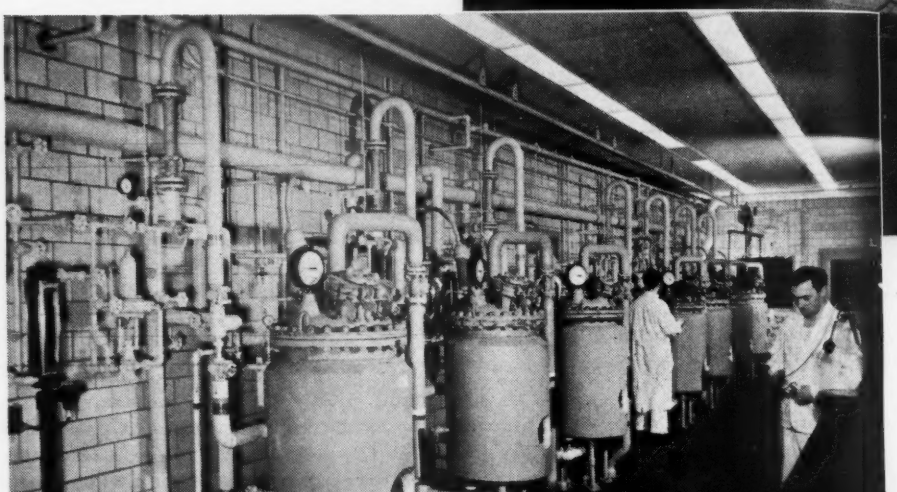
Life-Saving Chloromycetin

How Parke, Davis & Company Produces a New Mold Growth That Fights Certain Disease Germs

A. M. Brodine



PHOTOS, COLOR-GRAPHIC STUDIOS, DETROIT



FERMENTATION TANKS

The growth of chloromycetin culture is progressive from test tubes to large receptacles, and it must all be carried on in a sterile environment. Parent cultures prepared in the laboratory are introduced into seven 50-gallon pre-seed fermenters (above) where they feed on a nutrient solution containing wheat gluten, glycerine, sodium carbonate, and sodium chloride. Sterilized compressed air contributes to the growth and also helps to agitate the contents to insure maximum contact. After 24 hours the mixture is transferred by air pressure to 500-gallon intermediate tanks, where further growth takes place, and then to 5000-gallon tanks (top picture) where the organisms reach maturity. The chloromycetin is extracted from the liquid by filtering and, following chemical treatment, is evaporated to final crystal form. Fermentation units are made of Inconel-clad steel, and all piping is of Inconel.

IN THE little Bolivian town of Puerto Acosta, Senor Gregorio Zalles lay wracked and wasted from three weeks of suffering. He had been caught in the typhus epidemic that hit Bolivia in 1947. The town's undertaker, in an effort to keep up with the incidental paperwork, had already filled out Senor Zalles's death certificate—all but the date.

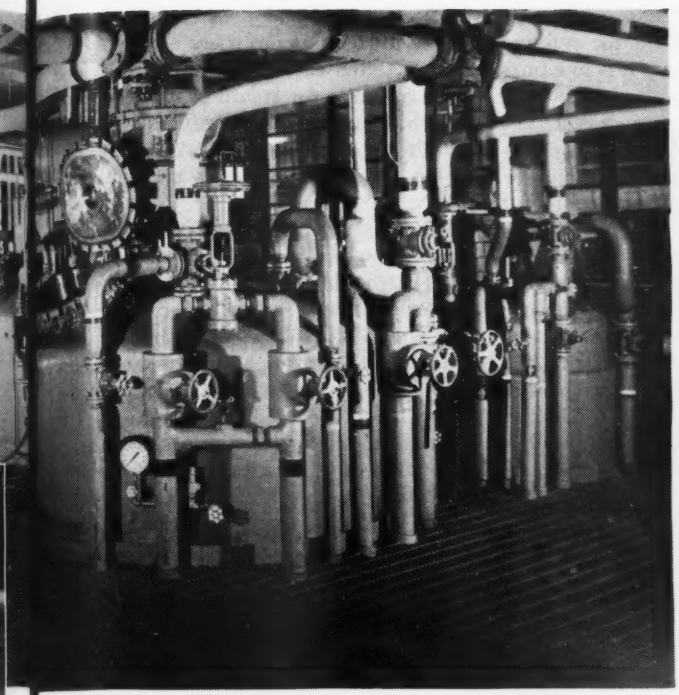
In Detroit, Mich., 6000 miles to the north, Dr. Eugene H. Payne of Parke, Davis & Company's Department of Clinical Investigation was getting ready to fly to Bolivia, not to fight the epidemic but to receive a government decoration for his war work. But Doctor Payne had heard about the epidemic in the Latin American country. He also knew that his firm's research laboratory had been collaborating with Yale University on a new drug to fight hitherto incurable diseases such as typhus.

Doctor Payne recalled that the scientists working on the problem had isolated a new mold from a soil sample that had come from a field near Caracas, Venezuela. From the mold they had produced a substance which they named "chloromycetin" and which had demonstrated powerful activity against the typhus virus in laboratory tests. So Doctor Payne took with him to Bolivia all the substance that was then available in the world, a little less than half a pound. Just enough, as it turned out, for 22 patients, one of whom was Senor Zalles for whom all hope of recovery had been abandoned.

With pulse faint and thready, and his body temperature down to a subnormal of 95°F., Senor Zalles was given a dose of 2/10 gram of chloromycetin.Forty minutes later he asked for water, the first words he had spoken in three days. First by injections into his blood stream, because he was too weak to take medicine by mouth, and then orally he received additional doses for two days. His voice came back. He demanded food. In one week he was up and smiling. Similarly, the 21 other patients treated with the limited supply of chloromycetin recovered, and in a surprisingly short time. It was the first time a drug had cured typhus, a fever known by one name or another in every corner of the world and one that has killed millions. Science had discovered a new antibiotic! As for Doctor Payne, the Bolivian Government wanted to decorate him before the epidemic occurred. Now they have named a new hospital after him!

Upon the conclusion of more tests (notably in Kuala Lumpur, Malaya, against scrub typhus and in Baltimore against Rocky Mountain spotted fever), scientists of Parke, Davis & Company, knowing that the new antibiotic had been proved to be effective against typhus and related diseases, decided to put chloromycetin into mass production. One unusual phase of this step was that the drug was to be made by two methods: one, a biological process that had been developed for the production of previously discovered antibiotics and that called for quantities of sterilized compressed air; the other, a synthetic method that chemists had sought for years without success.

In the 20-odd years since Prof. Alexander Fleming isolated penicillin from bread mold, medical and research men have become increasingly aware of the remarkable curative powers of certain chemicals found in the soil as by-products of some of the earth's lowliest forms



INTERIOR OF 5000-GALLON FERMENTER

The spiral piping alternately carries steam and chilled water to first sterilize the nutrient solution and then cool it to the fermentation temperature of 82°F. Compressed air is introduced at the bottom through perforations in the ring or sparger. The central shaft, which revolves during processing, carries agitator blades. Each tank of this size is 17 feet high and has a diameter of 7½ feet.

of life. Nearly every cubic inch of the earth's surface harbors tremendous numbers of harmful organisms, many of them invisible even with the aid of the microscope. They feed on the living cells of plants and animals, and when these pathogens are present in large enough concentrations they cause diseases, some mild, some deadly.

Watching the rapidity with which these minuscule parasites reproduce, one early scientist calculated that a single cell, if allowed to multiply without interference, would soon form a colony of greater size than the known universe. Since the colonies do not reach such proportions in the soil, their natural habitat, it was reasoned that something must be curbing their growth. It was just a matter of time before someone discovered that Mother Nature's good housekeeping is responsible.

Not long after it was established by Pasteur and others that germs cause many human, plant, and animal diseases, it was determined that they also have their enemies in the form of "microbial antagonists." Even though they may not devour their foes outright, they do manage to put many germs out of business. Exactly how they do this is not known. The effect of antagonistic substances, of one germ on another, is said to be bacteriostatic rather than bactericidal; that is, they don't kill each other, but something they do or something they secrete makes it difficult or impossible for them to live together.

Microbiologists working in the latter part of the nineteenth century found that most disease organisms in the ground do not last very long when they are left to themselves. They learned that, with certain important exceptions, most germs disappear when placed in ordinary soil, though they multiply readily in soil that has been sterilized. In other words, it was recognized that there must be in the earth certain biological agents that attack and destroy them.

FIRST BENEFICIARY

His life despaired of and his death certificate filled out except for the date, Gregorio Zalles of La Paz, Bolivia, was given chloromycetin in 1947 to combat typhus fever. A week later he was out of bed and smiling. Today the new antibiotic is a potent medical weapon for fighting not only typhus infections but also other diseases, among them trench fever and Rocky Mountain spotted fever, caused by bacteria of the Rickettsiae family.

The presence of antibiotic substances in the soil was discovered about 75 years ago, but until recently they remained there, their enormous life-saving powers unrealized. Now it is known that one of the main reasons why most harmful germs in the ground vanish rapidly is because they are exposed to these antagonistic bacteria or fungi which produce substances that are definitely poisonous to them. These specific poisons are called antibiotics, of which penicillin and streptomycin are examples. When the parent organisms are separated from the soil and the antibiotics they yield are collected in their pure form they can be used to cure certain diseases. This simple fact is well known and widely accepted today as one of the great medical advances of the twentieth century.

Several antibiotic substances have been isolated and studied within recent years, but the only ones known to be of commercial importance prior to November, 1947, were penicillin and streptomycin. The third one discovered was chloromycetin. None is a wonder drug—none will cure everything. But chloromycetin does attack fevers such as typhus and typhoid, which the other antibiotics ignore. Like penicillin, it will not touch malaria and kindred illnesses caused by protozoal infection and is nonpoisonous —can be swallowed without harm. In

these respects it differs from streptomycin. So it has become apparent that each antibiotic will poison only certain microbes in the body and that it is ineffective against others.

Chloromycetin's history began with a grant made by Parke, Davis & Company to Yale University for the purpose of conducting a systematic search for new antibiotics. With Dr. Paul R. Burkholder in charge, some 6000 samples of soil were collected from every part of the globe, and the tedious task of isolating microörganisms was started. Of the more than 20,000 different molds that were investigated, only a few showed activity worthy of further research. The cultures obtained were subjected to study at the Parke, Davis Research Laboratory, where Dr. John Ehrlich and his associates devised methods of growing the molds. Of all those produced, the one that later yielded the substance called chloromycetin proved to be the most promising.

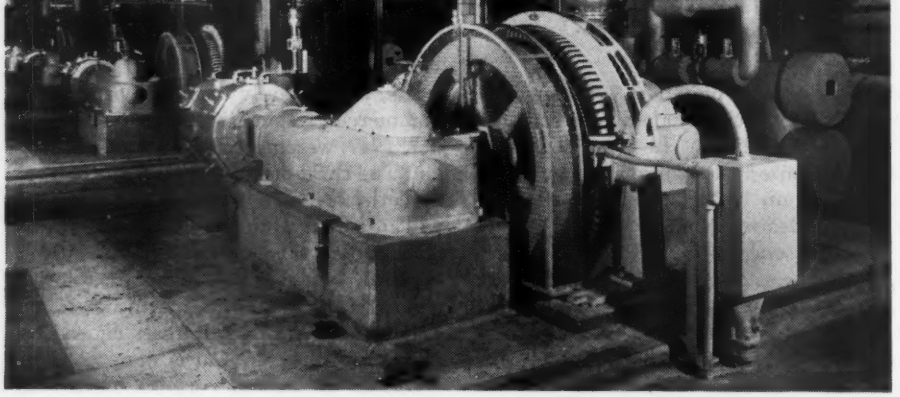
The company set a research team to work to determine the best way of growing the mold and of translating the laboratory process of making chloromycetin into a procedure suitable for large-scale operations, as well as to discover the potentialities of the material. In a short time the chemical constituents of the substance were no longer an unknown quantity and the other major problems had been solved. Because of these initial successes, the firm decided to produce the material not only biologically by growing it in special culture tanks but also artificially from the raw chemicals of which it is composed. So it was that Parke, Davis took the unprecedented step of developing two processes for the manufacture of the drug.

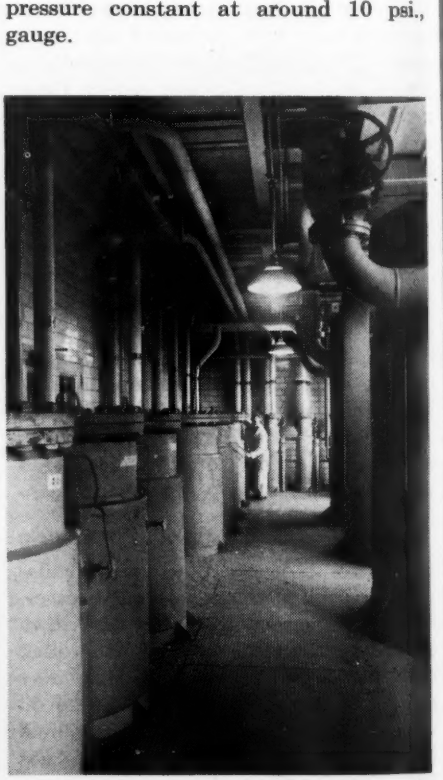
Production of chloromycetin was begun late in 1948. Raw materials arriving at the plant are stored and prepared in a receiving department that is isolated to confine dust. Included among them are ingredients for the nutrient medium on which the culture feeds, and other standard chemicals needed for refining the drug to the point where it is in a pure crystalline state. These, together with water and sterilized compressed air, make up the essentials. The entire mold-growing phase of the process must be carried out in a sterilized environment, otherwise there is no yield of chloromycetin.

Mass production of the mold, which is available in Nature only in minute quantities, is carried out in huge fermentation tanks supplied with nutrient and with sterilized compressed air, which is the microbes' breath of life. The air for this purpose is provided by four Ingersoll-Rand XRE units and is cleaned before compression by American Air Filter Airmat electrostatic filters and Dollinger Staynew felt filters. As the process also calls for oil-free air, the machines are of the nonlubricated type—that is, they have carbon piston rings that do away with lubricants in the air cylinders. The compressors are single-stage, duplex machines powered by 250-hp. synchronous motors and are mounted on Korfund foundations to eliminate vibration. They deliver air at a pressure of 50 psi. at the rate of 1680 cfm. to a group of steel receivers, whence it passes through stainless-steel mesh and carbon sterilizing filters before entering spargers —a system of perforated hollow arms— which "sprinkle" it evenly at 35 to 40 psi. throughout the fermentation tanks.

In the case of the biological process, the parent culture of the mold, *streptomyces venezuelae*, is kept dormant in sterilized earth refrigerated in an incubator. From time to time agar slants (culture mediums solidified obliquely in test tubes to increase the surface area) are seeded with the culture and grown under carefully controlled sterile conditions until spores are formed. The latter are then washed from the slants with sterile water, and the suspension thus obtained becomes the initial seed for fermentation. This process starts in the pre-seed room where there are seven 50-gallon tanks each of which is provided with a jacket for steam or chilled water and with an air sparger. This is the beginning of a train—a series of fermenters —the capacity of which is multiplied by ten at every stage.

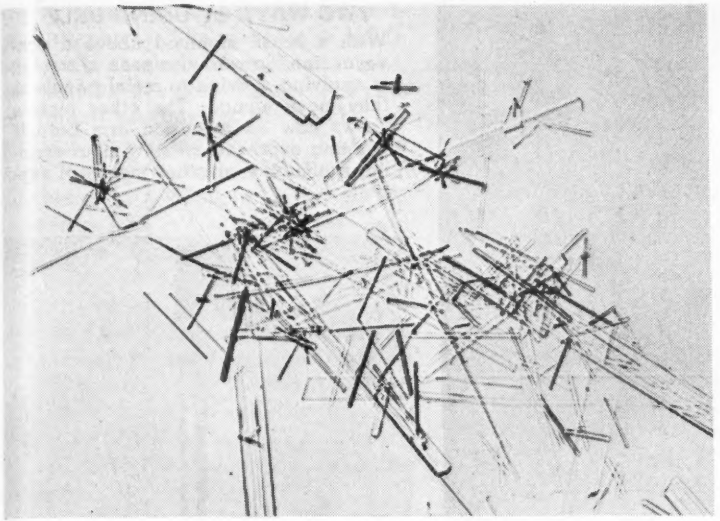
Each tank is charged with the nutrient medium, which is diluted to the required strength with deionized water. Next it is sterilized and cooled by first circulating steam at 252°F. and then chilled water at 48° through the jacket. Now the unit is ready for inoculation with the chloromycetin mold produced in the culture laboratory, and this is done in an ingenious way. It is brought to the pre-seed room in a sterilized syringe and injected into the vessel by inserting the needle into and through a self-sealing rubber diaphragm. There the culture multiplies under sterile-air agitation and at a temperature of about 86°, cooling water passing through the jacket under automatic control extracting the heat incident to growth and maintaining the temperature at that point. In-leakage of contaminated air is prevented by a back-pressure valve which keeps the internal pressure constant at around 10 psi., gauge.

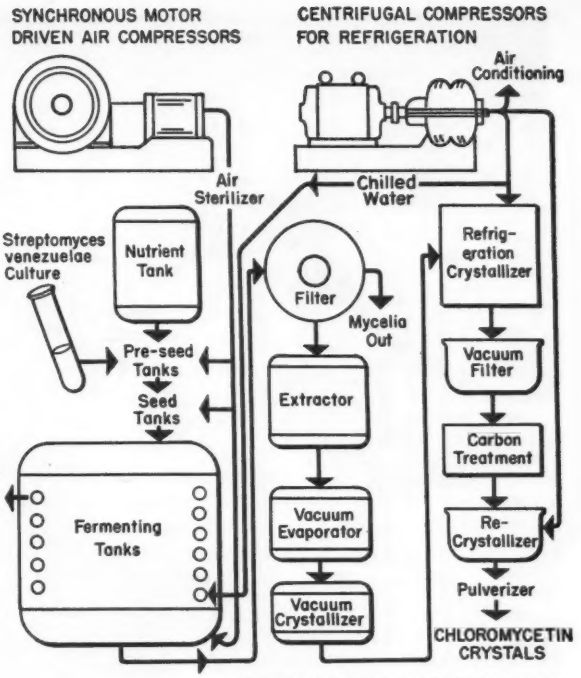




COMPRESSORS AND AIR STERILIZERS

Oil-free compressed air is supplied by four Ingersoll-Rand single-stage compressors (left) that are fitted with carbon piston rings to obviate the need of cylinder lubrication. Each machine has a capacity of 1680 cfm. and is driven by an Electric Machinery Corporation 250-hp. synchronous motor. Intake air is filtered and, following compression, is passed through steel mesh and carbon in the tanks shown above where it is sterilized with live steam.





COURTESY, ELECTRIC MACHINERY MFG CO.

FINAL PRODUCT AND FLOW CHART

Shown above are crystals of pure chloromycetin magnified 150 times. The substance is a white powder that is more resistant to decomposition than most antibiotics. The chart at the right illustrates the principal steps in the cycle by which test-tube seed spores are transformed into the finished product.

After approximately 24 hours, the contents of the 50-gallon tank are blown by sterile air into a 500-gallon intermediary fermenter freshly charged with sterile nutrient. From there, following another day's development under like conditions, they are similarly shifted to a 5000-gallon tank where the organism attains full growth in about 76 hours. After this final stage of fermentation the tank is emptied under air pressure into a 3000 gallon acid-adjusting unit which serves as a feed tank for the filtering operations that follow.

Filtering involves separating the mold in the broth from the chloromycetin by a continuous process. Two pressure filters, precoated with a diatomaceous filter aid in suspension in deionized water, are used for this purpose. Each has 50 square feet of filtering surface and handles one batch at the rate of 1000 gallons per hour under a pressure of 20 psig. The solids obtained at this stage are discarded, and the filtrate containing the chloromycetin in solution is further clarified by mixing it with amyl acetate in an extractor. This is followed by concentration under a 0.3-inch vacuum induced by a 3-stage steam-jet ejector.

The resultant concentrate, consisting of chloromycetin in about 30 gallons of amyl acetate, is withdrawn from the evaporator; is washed with acid, alkali, and water; and is then put in a small, glass vacuum crystallizer where the remaining amyl acetate is vaporized, leaving a residue containing crude chloromycetin crystals. By the time this stage has been reached the volume has been reduced to about 2 gallons. Further purification and recrystallization yield pure chloromycetin crystals, which are placed in an atmospheric tray drier. From there, they are transferred to a micropulverizer for final reduction prior to screening, packaging, and shipping.

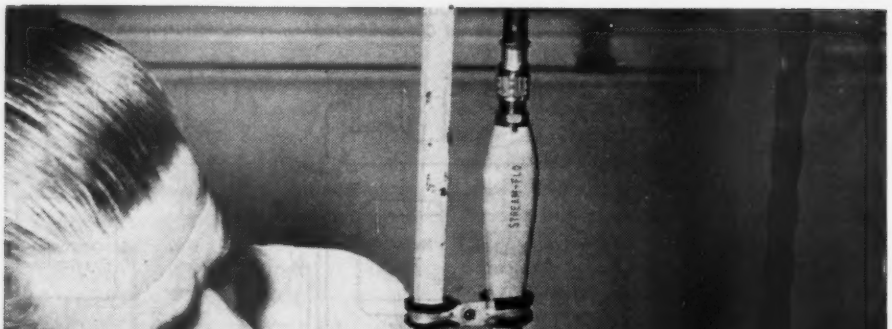
With a new antibiotic to its credit, it would have been understandable had Parke, Davis & Company rested on its laurels, especially as it had developed a commercially practicable method. That, however, was not the case. Ever since the curative powers of penicillin were recognized, pharmaceutical laboratories had been trying to produce antibiotics artificially. For unlike sulfa drugs, which are man-made from start to finish, all antibiotics were the end product of fermentation processes like that just described. These processes are tricky, and contamination must be guarded against every step of the way. If chemists could make the life-saving molecules out of common chemicals it would mean more medicine for less money. But until Parke, Davis attacked the problem of synthesizing chloromycetin, no success had been achieved in this field.

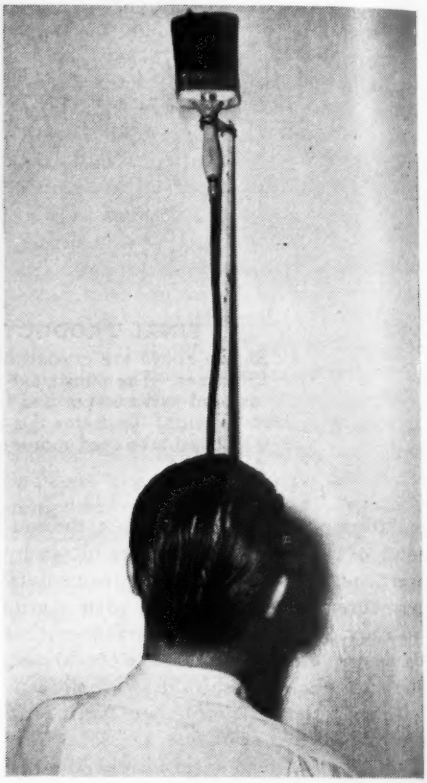
In the case of chloromycetin, however, the compound, as has already been mentioned, was quickly isolated, proved, and synthesized. Moreover, the company put both the fermentation and the synthetic method into production in the space of two years. After the chemical had been discovered, the next step was to find out what it was. By using standard but delicate laboratory apparatus, Parke, Davis researchers identified one element after another in the compound and finally came up with its formula. The next problem was to build a molecule exactly like the one found in Nature. Difficult though the previous step had been, this one was tougher. Molecules, like other solids, are 3-dimensional, and it developed that there were four chloromycetin molecules, all of the same chemical formula but with their atoms arranged differently. And only one was an effective germ killer.

The goal was finally reached, and the trick of getting all the atoms into their proper positions was turned by Dr. Mildred Rebstock, one of the company's research chemists. The synthetic product was matched against the natural one in the laboratory, and in every respect—melting point, analysis, optical properties, and so on—the two were identical. But even though the chemists were certain that their drug was the same as the natural substance, other Parke, Davis scientists had to prove that their disease-fighting properties were the same.

Today, the crystals are being produced in large quantities by a relatively complex procedure that involves ten chemical reactions and about 30 steps, not including recovery operations. But for a comparable output it does not require as much working space as the biological process. Furthermore, contamination presents no problem.

An interesting feature of the Parke, Davis plant where chloromycetin is produced is its adaptability. Originally planned for making streptomycin, it was designed so that it could, with only slight modification, be used to produce other antibiotics. With a minimum of repiping and without additional equipment it can be converted from chloromycetin to penicillin, streptomycin, or any other antibiotic that may be discovered. This farsightedness on the part of the builders can be appreciated now, for even though chemists are unraveling Nature's antibiotic puzzles little by little, it is doubtful if new antibiotics can be discovered without her help.





TWO WAYS OF USING BRUSH
With a brush mounted above a conveyor line the workman seen at the left is applying a stripe to metal panels as they move along. The other picture shows how an extension arm permits painting overhead areas without erecting scaffolding or other means of support.

Pressure-Fed Paint Brushes and Rollers

New Devices Increase Rate of Applying Coatings and Reduce Human Effort

John Starr

RECENTLY developed pressure-fed brushes and rollers for applying paint and other protective coverings are gradually being adopted by industrial firms and commercial painters for both conventional and unusual coating operatings. In industrial finishing, they have so far been most used where other types of equipment would be impracticable; for example, where spray booths are not available or where it is desired to cover only a part or parts of the article being finished.

The principal advantage claimed for pressure-fed applicators over ordinary hand-wielded brushes is that they eliminate the need of periodically dipping the brush into a pot every time it needs replenishing. This unproductive operation is said to consume up to one-third of a brush painter's workday. In addition to the time thus lost, it results in increasing fatigue and tends to slow up his efforts.

Both brushes and rollers have been used to apply virtually all kinds of oil-, solvent-, and water-dispersed coatings including glossy and semigloss enamels, egg-shell or stipple paints, and lacquers with aluminum or other metallic pigments. Paints containing silica or other grit have been put on with brushes, but their application with rollers is not recommended.

In general, rollers can be utilized wherever the surfaces involved are large and relatively flat. They will do this sort of work, it is claimed, almost as fast as spray guns and with no loss of material caused by dripping, uneven spreading, etc. Pressure-fed brushes will also cover large areas with considerable speed, but they are most useful where surfaces are not uniform, or not entirely accessible to rollers. In the case of silk-screen stenciling, rollers and fluid coatings greatly reduce the time it takes to apply semifluid materials with a squeegee and cut costs by permitting the use of solvent-dispersed coatings. Pressure-fed brushes have shown comparable advantages in duplicating figures, letters, or designs by means of mask-type stencils.

By changing over to pressure-fed brushes for spreading resinous or liquid adhesives on wood veneers and other materials, one manufacturer of laminates and assemblies has doubled the productivity per worker. Rollers have served with equal effectiveness for the application of stripping compounds or solvents in removing worn or defective coatings.

So far as is known, neither brushes nor rollers have yet been utilized in connection with heated materials, so it is possible that work of this kind must await the development of applicators of special design. When these are available, they should offer the same advantages as do spray guns, because coatings of considerable thickness could be applied and dried with optimum speed.

Either brushes or rollers may be attached to extension arms to increase a finisher's reach, thus eliminating the need of ladders, scaffolds, or other supports for a wide range of operations. Where assembly-line work permits the use of conveyors, completely automatic coating is possible by mounting pressure-fed applicators on special fixtures above or near the conveyors. By way of example, an accompanying illustration shows how a brush is held in a fixed position to put colored stripes on conveyor-borne panels.

Typical pressure-fed brushes are the

Stream-Flo products of Hanlon & Goodman Company. The material is fed to the handle through a connecting hose, and a small valve near the worker's natural thumb position on the handle enables him to regulate the flow. The fluid passes through a channel in the handle and thence to a small brush set within the bristles and at the base of the main brush. The purpose of this insert brush is to insure good distribution. With a little experience in manipulating the valve, an operator is said to be able to maintain a constant flow to the working edge of the brush. As the method of application is the same as that with an ordinary brush, anyone accustomed to painting has little difficulty in using the new type.

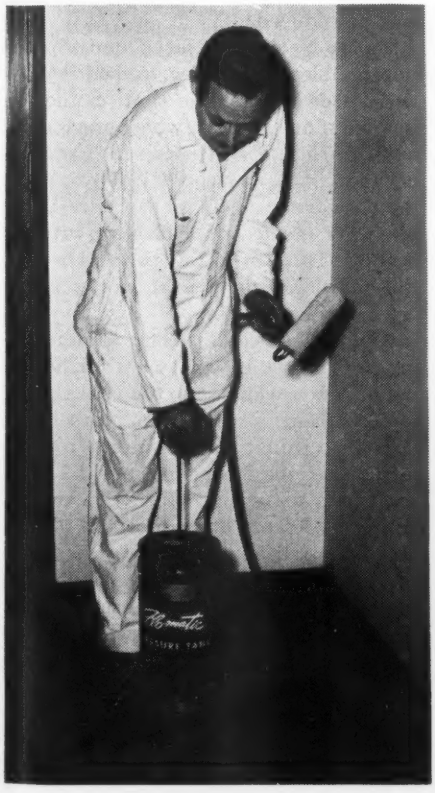
Our readers have already been introduced to the pressure-fed roller through a picture on the front cover of our June, 1950, issue of a unit manufactured by Rubberset Company of Newark, N.J. A typical roller such as that made by Schaefer Self-Feeding Paint Roller Company is supplied with material in much the same manner as are brushes. A finger-tip control valve on the handle regulates the flow to a hollow brass-lined hardwood roller. Radial holes drilled in the roller walls connect with circumferential-longitudinal grooves in the exterior surface which deliver the coating to a deep-pile wool covering. The latter can be replaced by a knitted oversleeve when it is desired to apply glossy enamels or tacky paints.

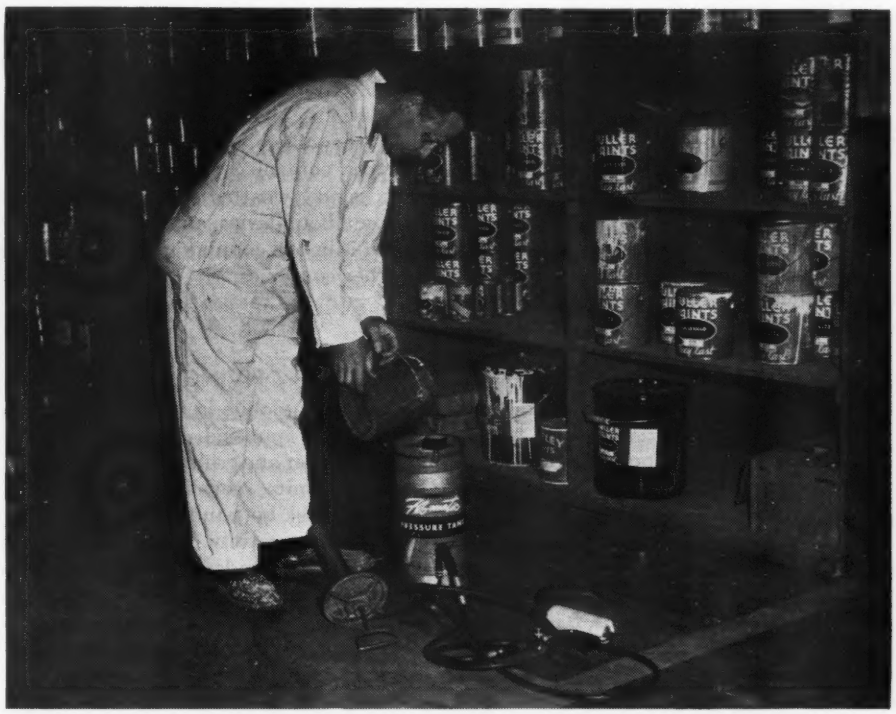
The feed tube in the handle is of stainless steel, and "O" rings at the ends of the roller provide seals that prevent leakage. The entire unit weighs only 13 ounces and can be assembled or dismantled in a matter of seconds. After use, either rollers or brushes and their accessory equipment can be cleaned with appropriate solvents or thinners in the same way as ordinary brushes or spray-painting apparatus.

In the case of either brush or roller, the coating material is supplied continuously through a hose extending from a tank that is kept under pressure. Tanks fitted with hand pumps for charging them with air are available, and cylinders of commercial gases such as carbon dioxide may be used for the same purpose. These pressure sources are satisfactory for small-scale, intermittent industrial operations or where the working location is changed frequently, as is the case in commercial painting. However, where finishes are applied on a production basis, as in a manufacturing plant, it is usually more economical and preferable to obtain the necessary pressure from existing air-distribution lines or from a small motor-driven compressor such as is used to power spray guns. A unit of this type easily maintains the required pressure (from 10 to 50 psi.) and permits operations to continue without interruptions. If the pressure of the air is higher than is needed, it can be lowered by means of a reducing valve.

A single pressure tank can, when provided with "Y" or "T" fittings, furnish paint or other coatings simultaneously to as many as eight brushes or rollers, the size of the tank depending upon the amount of work to be done. It is usually desirable to have one large enough to hold sufficient material for a given job or for a day's work. For maximum speed there should be a separate container for each color to be applied, as this obviates delays incident to cleaning and refilling. One brush may, however, be used alternately with different colors without appreciably retarding operations. Organic coatings and the like are mixed and screened into the pressure tanks in the same way as in spray painting, and when this is done as it should be the frequent thinning required in ordinary brush-coating work is unnecessary.

Brush marks, sag lines, and other defects do not result when materials are properly applied with pressure-fed units because the flow can be regulated for uniform distribution by light applicational pressure which, incidentally, lessens worker fatigue. However, the new brushes and rollers can, like all types of equipment, be misused or abused by careless or inexperienced finishers. Many painters, when using them for the first time, complain that it is difficult to maintain the flow at the rate that prevents waste of material and defective surfaces. However, when the men are provided with "wiping buckets" for the reclamation of excess material until they become accustomed to operating the flow-control valves they are normally able to do a good job well-nigh from the start.

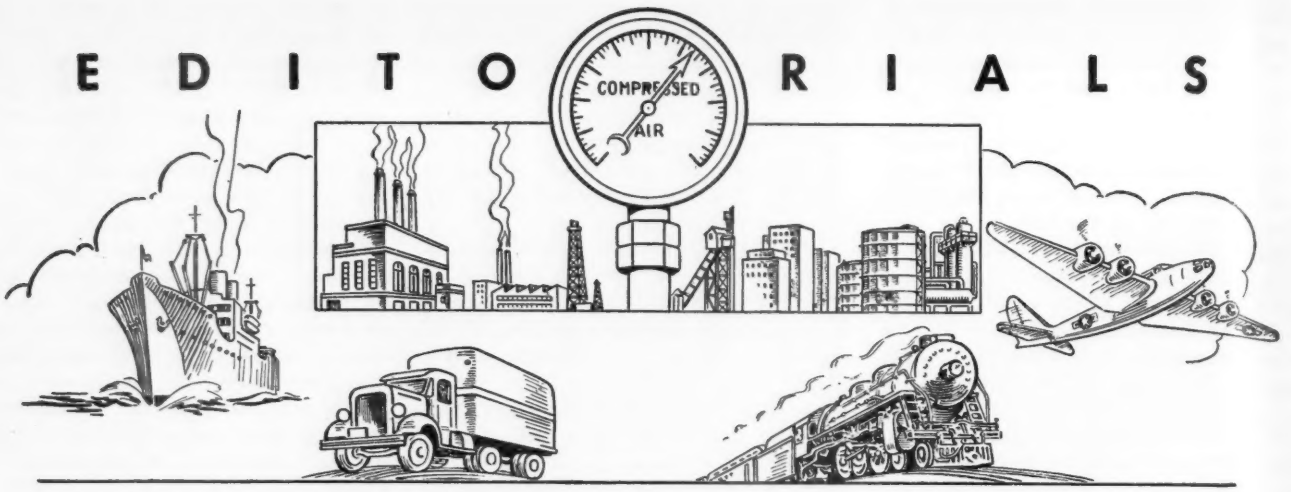




HAND-PUMPED SUPPLY TANK

The paint or other coating to be applied is poured into a pressure tank, as illustrated at the right. The cover is then put on and air is pumped into the space above the liquid with a hand pump (above) until the desired pressure is reached. In his left hand the painter is holding a roller, with his thumb on the valve that controls the flow of material. In industrial operations, the air is generally supplied by existing distribution lines or by a separate small compressor.

EDITORIALS



MAN-MADE RAIN

EXPERIMENTS conducted during the past year seem to indicate clearly that rainfall can be increased by cloud-seeding. Scientists working in arid New Mexico had surprisingly good results from Jupiter Pluvius and are able to prove rather conclusively that their efforts were primarily responsible for an increase in precipitation. Across the country, a professional rainmaker employed by New York City in an attempt to fill the reservoirs of its water-supply system also ostensibly delivered the goods. In that case, however, it was impossible to say definitely that the rains would not have come without recourse to human cloud-letting.

A recent report on the New Mexico activities by Dr. Irving Krick, former California Institute of Technology scientist who directed them, is both enlightening and convincing. Clouds in a 125-square-mile area around the town of Roy were regularly sprayed with silver-iodide particles during the month of July. Within the section are twelve official Federal weather stations that have kept records for many years. At five of the stations the rainfall last July was of unprecedented proportions. At Roy it amounted to 8.55 inches, or 419 percent of normal. In the town of Capulin, it was 10.26 inches, or 394 percent of normal. Outside the seeded area the story was different, the precipitation recorded at various stations ranging from 0.46 inch to 2.69 inches, or from 33 to 125 percent of normal. In Santa Fe, for instance, the total for the month came to 1.53 inches, or 63 percent of normal for that locality.

Making the rain come down is not, however, as simple as it sounds. Dr. Krick emphasizes that unless it is going to rain anyhow, cloud-seeding will not produce results. "We are rain-increasers, not rainmakers," he says. The mere occurrence of rain during or following a seeding operation is no measure of its success. To prove that it was successful, you must prove that more rain has fallen than unaided Nature would have delivered.

"We know of an instance where rainfall from a seeding project was increased up to 200 percent of normal. The only trouble was that the increase didn't occur where it was ordered. Instead, the rain fell 100 miles outside the target area. At the same time, the rain in the target area was only half what it would have been had no seeding operation been undertaken."

Such undisciplined rainfall can lead to serious domestic political complications and may even stir up international discord, in the opinion of Dr. Irving Langmuir, General Electric Company consulting research scientist who discovered the silver-iodide seeding method. He believes that such seeding operations must eventually come under Government control, and adds that no matter how the control is administered it will not be able to please everybody.

"The compromises required to obtain the greatest good for the greatest number will very likely take cloud-seeding into the field of politics," he continues, "and we may be able to look forward to political speeches charging that one party or the other has hopelessly mismanaged weather control." He predicts further that, since weather does not respect national boundaries, any large-scale control of it in one country may have effects in other countries.

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WINTER DRIVING HAZARDS

THE automobile is unquestionably a boon to mankind, but it is also the greatest killer and maimer ever invented. Like dynamite, gasoline, or sulphuric acid, it must be handled with extreme care. Unfortunately, people think only of the pleasant side of motoring. The millions who sit down behind steering wheels each day do so with little trepidation, despite the tragic reports of crack-ups that meet their eyes every time they pick up a newspaper.

Because of the auto's lethal potentialities, it is the main target of safety campaigners. Their warnings are even more forceful than usual at this time of the year, when winter adds hazards to those already existing. No one is naive enough to believe that we will ever reach that utopian state where all drivers will always exercise caution, but it is only by repeating and emphasizing motoring "don'ts" that the number of accidents can be reduced.

As the National Safety Council points out, ice, sleet, snow, fog, and early darkness issue challenges that cannot be ignored if one is to get where one is going and return safely. Having the car properly equipped and conditioned for cold-weather driving helps, but the responsibility for a safe trip still rests with the driver. Those who fail to take heed of the additional perils that winter brings are courting disaster.

Among the tested tips for winter driving contributed by safety authorities are these: Use tire chains to help braking up to 50 percent; always signal your intention of turning; pump brakes to stop rather than suddenly jab the pedal down and risk a disastrous skid; keep tires at uniform pressure to reduce the chance of skidding; keep steady pressure on the accelerator—under a sudden letup the engine compression may cause a skid; if you should skid, turn the wheels in its direction, not against it.

Tests conducted on frozen lakes in Wisconsin and Michigan show that a car that can stop from a speed of 20 miles an hour in 20 feet on dry concrete requires 70 feet on packed snow and up to 250 feet on wet ice. At 40 miles per hour, the corresponding figures are 80, 280, and 1000 feet. It is good sense to take a little longer to get there at this time of year.

A holiday greeting in safety magazines last month wished readers "A Wary, Merry Christmas." Automobile drivers might well adopt it as an appropriate slogan, not only for the holiday period but also for the entire winter season.

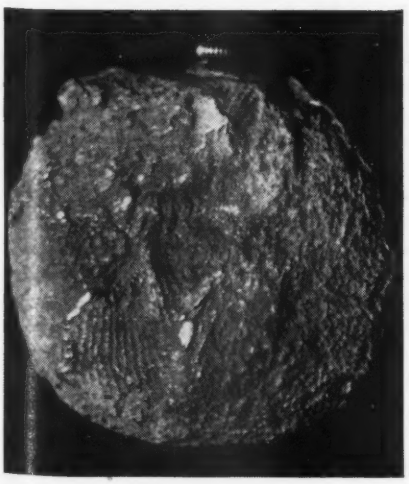
This and That

Molten Lead Baptism

Philip L. Christianson, general superintendent of the Perth Amboy, N.J., plant of the American Smelting & Refining Company, owns a watch that is half-encased in lead, as shown in accompanying pictures. Nevertheless, it continues to function perfectly. How it acquired the lead sheath is best explained in Mr. Christianson's own words, as reprinted, by permission, from the November issue of his company's *Asarco News Letter*:

One day in 1941, when we were carrying on some experimental work on debismuthizing lead at Monterrey, I was helping to push the dross across the kettle to the skimmer. A mixer was set in the kettle. During the movement of my arm my glove caught my watch chain and the watch, an Elgin pocket model, flipped into the center of the molten lead (750°F.). By chance the watch landed face up after traveling a distance of about six feet. I immediately walked out on the mixer, reached down and with my gloved hand snatched the watch out of the lead. It was too hot to hold and the glove stuck to the lead frozen to the watch.

I slipped off the glove and set the glove and watch to one side to cool. I assumed heat or shock would have ruined the works but to my surprise, when I picked it up after cooling, it was still running and accurately—which it is still doing. I have carved away enough of the lead to free the stem for winding. The glove was peeled off, leaving the design of the weave on the lead shell. Use of the watch as a pocket timepiece is definitely out as it now weighs over a pound. Perhaps the quality of semi-debismuthized lead for lubricant sealing purposes should be investigated since this watch, after nine years without being able to clean or oil it, is still the best timepiece in the house.



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It Really Snows in Michigan

Removal of snow from roads and streets in Michigan last winter cost approximately $13,500,000, according to the State Highway Department. Of this total, the state spent $3,500,000 on trunk-line highways and counties and municipalities expended $10,000,000 on roads and streets. Under a state law, counties that experience a snowfall of 60 inches or more in any one year receive funds from state gasoline-tax collections. Last year 58 of the 83 counties participated in the distribution.

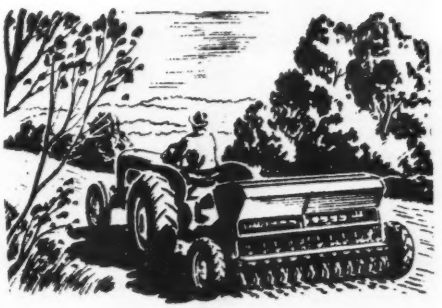
Because Michigan is a large and populous manufacturing state, it is deemed highly important that roads and streets be kept open at all times so that commerce can move freely. Consequently, snow removal is a well-organized activity and pretty much of a year-round job for the highway department. In late spring all equipment is inspected and overhauled to put it in first-class condition for the following winter. In late summer and early fall the maintenance crews stockpile sand, sodium chloride, and calcium chloride at strategic points and put up some 600 miles of slatted wooden snow fences to curb heavy drifting. In addition, another 150 miles of roads is protected by rows of trees.

★ ★ ★

Pipe-Line Operators Are Farmers

The companies that operate our fast-growing network of petroleum and natural-gas pipe lines are vitally interested in farming, even though they may harvest no crops. Erosion can do untold damage to their buried lines unless it is checked, and the best surface protection is provided by proper planting. The companies are, consequently, concerned with maintaining suitable cover crops on their rights of way. For obvious reasons, their interest also extends to bordering acreage, and there they must obtain the coöperation of the land owners or tenants. To do this, the larger concerns have conservation departments that offer the farmers help in selecting crops and methods of cultivation that will produce the best results.

An example of this educational movement is found in the case of the Texas



Gas Transmission Corporation which operates 2400 miles of pipe lines in nine states extending from Texas to Ohio. Beginning in the fall of 1949 and continuing through the spring and summer of 1950, eight crews, using modern machinery, seeded all sections of the right of way that are subjected to erosion. As the company merely has easements on the land where its lines run, this involved getting in contact with the farmers all along the route and putting in the kind of growth that would, in each instance, fit into their scheme of cultivation. Where the tenant planned to farm the land, a temporary winter cover crop was planted; otherwise a permanent pasture mixture was seeded.

In addition to seeding, the work entailed fertilizing, terracing the land to minimize erosion and, in some places, digging ditches to divert runoff water following storms. The program was directed by staff members of the corporation's soil-conservation department, all of whom are graduates of agricultural colleges and have had years of practical experience. In all cases, county agents and other agricultural authorities in the sections concerned were consulted and final agreement on the planting was made with the farmers themselves.

To pave the way for the planting operation, Texas Gas Transmission distributed to the farmers along its lines a booklet, *Conserving Your Soil*, which sets forth the damaging effects of erosion and outlines the free services the corporation offers to combat it. This was done primarily as a good-will gesture. The publication points out that it takes Nature 10,000 years to form a foot of top soil, which may be carried away within the span of one lifetime unless proper precautions are taken to prevent it. Mention is made that in 1934 the National Resources Board estimated that 35 million acres of farmland had been so badly damaged by erosion that it was beyond reclamation for agricultural purposes. The same authority stated that 30 percent of all crop and pasture land had lost part or all of its original plow layer of soil. Each year, it is computed, 126 billion pounds of plant food contained in the soil is washed away.

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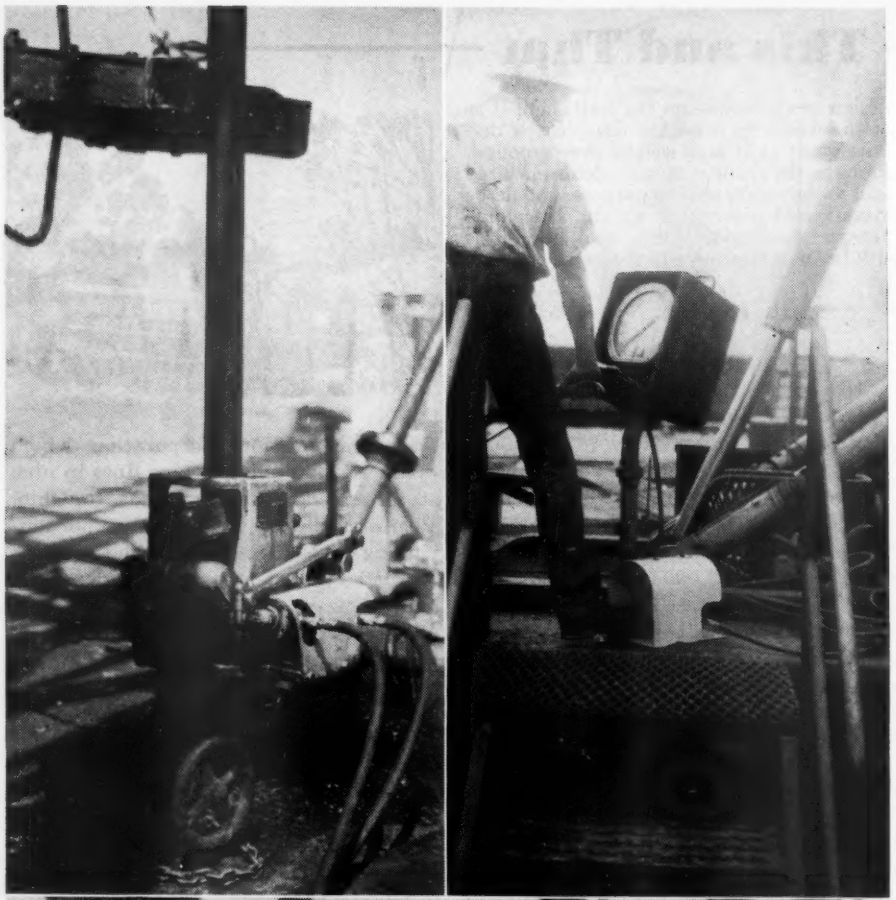
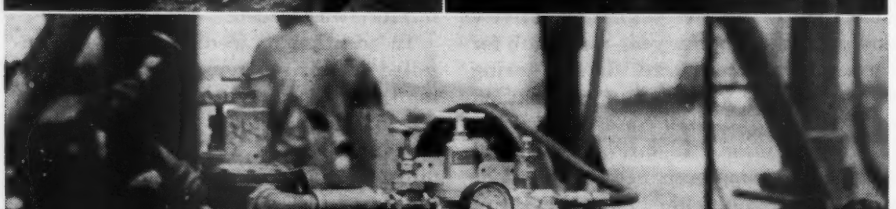




COMPONENT PARTS

The view at the top-left shows the air-powered spider in place on the well head and supporting a string of tubing. Ready to grip the latter are the tongs (top) that are used to screw or unscrew sections in making up or disconnecting tubing. The tongs also are air operated. The pneumatic cylinder that applies and releases the slips is an integral part of the spider and is pictured with the control-valve hose connections attached. The valve is of the foot-operated type (top-right) and is protected by a cover guard to prevent accidental tripping. Pictured at the bottom is the filter-lubricator-pressure regulator that is interposed in the main air-supply line.

Air-Powered Tubing Slips for Oil Wells

IN RUNNING tubing in or out of oil wells, the sections of which it is made up must be screwed together or unscrewed and the long string in the hole must be held securely the while to prevent it from falling to bottom. This is done by applying wedge-shaped gripping jaws, commonly called slips, at the point where the tubing passes through the casing opening. Until fairly recently the job was performed by hand. Now, air power has relieved the well-servicing crews of this work, with the result that fatigue has been reduced to zero and the attendant hazards to both men and equipment have been eliminated.

The new device, known as the Air-Powered Tubing Spider, was developed by the Advance Oil Tool Company, Long Beach, Calif. It is a companion piece to the air-operated equipment which serves to hold drill pipe under similar conditions and which was described in an article, entitled *Compressed Air—New Oil-field Roughneck*, in our March, 1949, issue.

Of simple design, the spider consists essentially of four slip segments housed in a tapered bowl and encircles the tubing at the well head. The slips, which have teeth cut on the inside that conform to the curvature of the tubing, are powered by a double-acting air cylinder. When actuated by the latter, the segments slide down into the bowl and, upon reaching the end of their travel, grip the tubing firmly. Simply reversing the cylinder stroke and hoisting the tubing slightly to take the weight of the string off the slips causes them to retract so that the tubing may be either lowered into or lifted out of the well.

Only 35 to 40 psi. pressure is required to perform the work and is provided by stepping down the reservoir pressure with a regulator, which comes with the equipment. The entire operation is controlled by a foot valve at the hoistman's station, and the air is delivered to the valve and thence to the pneumatic cylinder by means of flexible, oil-resistant hoses with quick-change couplings. The device has undergone months of field tests and is said to be highly practicable.

Well, Well — the Low Well is at Lowell

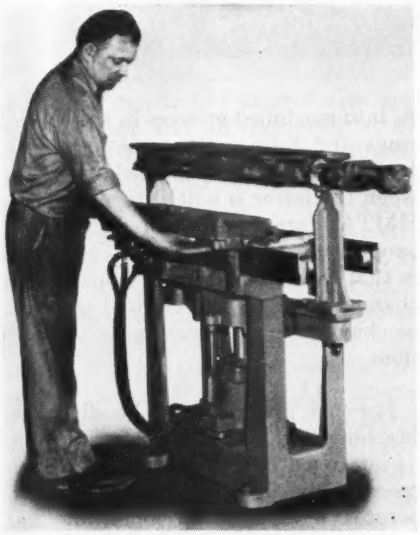
TWO experts were doing some figuring involving the temperature of water for a job at Lowell, Mass. Said one expert to the other, "They must have an awfully low well at Lowell." Whereupon the other inquired, "Why? What makes you think so?"

Explained the first, "Upon looking through this table of maximum water temperatures in prominent cities I notice that Lowell has the lowest maximum in the United States. The temperature of the water never goes higher than 50°F."

"On the other hand," he continued, "just to prove that Shakespeare was right when he said 'What's in a name?' the table shows that Highland Park, Mich., has a maximum of 77°F. But that isn't the highest. That honor in the United States goes to Austin, Tex., where the maximum is 96°F."

Industrial Notes

Designed to accommodate core boxes from 24 to 36 inches in length, Spo Incorporated's new Model CD-36 core-drawing machine is said to perform a complete cycle in from 18 to 42 seconds, depending upon the type, size, and number of cores. It is suitable for operation

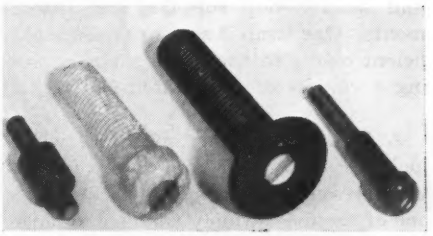


with any type of core blower and can be used singly, in pairs, and in circular high-production conveyor systems. The box is positioned by parallel sets of ball-bearing rollers and guide rails, the core plate is clamped in place, and the box is lifted pneumatically for manual roll over and lowering onto the plate supports. Release of the clamps permits drawing the box for core removal and subsequent handling. A feature of the machine, which is powered with air at a line pressure of 80 psi., is a lifting mechanism and yoke that eliminates the need of links and squaring shafts. An adjustable secondary stop is automatically positioned by the unit's 4-way control valve before the actual draw so as to prevent core damage. Machines to meet core-blower requirements are made to order by the company.

Accident prevention is the purpose of an alarm system that works automatically when backing motor trucks and cars. A product of B. F. McDonald Company, it is a single-stroke electric gong that is connected to the vehicle battery and to an interrupter switch actuated by reverse action at the speedometer-cable takeoff on the transmission. It is named Reversalarm and sounds a sharp warning during the first 8 inches of reverse movement, giving anyone standing behind the truck ample time to get out of the way.

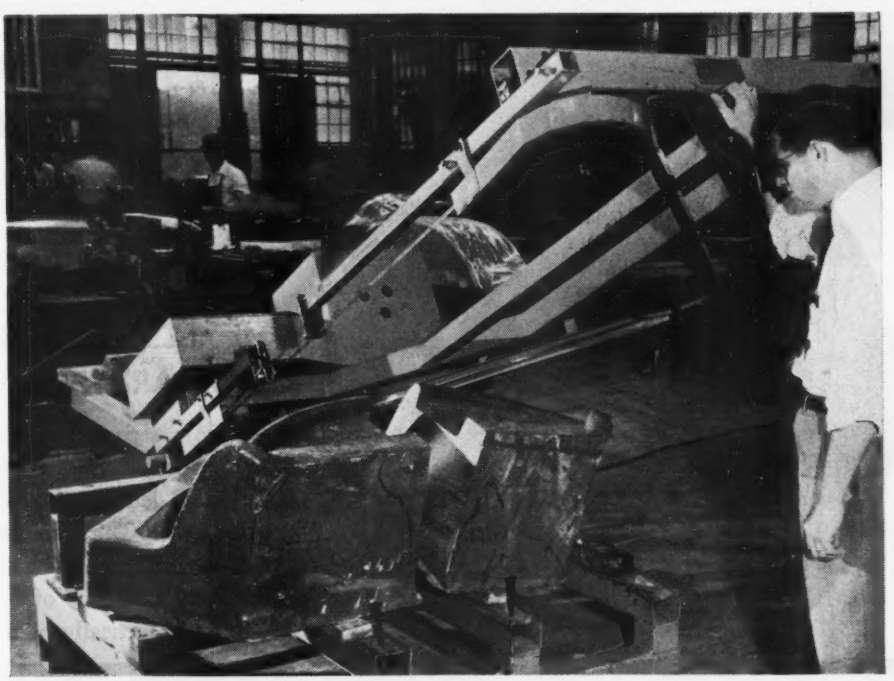
By substituting electric heat for the customary thinner and applying paint at its ideal spraying temperature, Associate Painting & Japanning Company has, it is claimed, cut rejects 99 percent! Among the factors that contribute to this result are: high-quality finish and better gloss; a smoother, less porous film structure; less shrinkage and greater coverage of surface imperfections; and virtual elimination of runs, sags, and orange peel. Furthermore, one coat of paint is adequate because more solids are applied by hot than by cold spraying, thus insuring a heavier, more uniform film.

Metal and plastic have been combined in a new type of fastener that serves both as screw and insulation. Called the Forman Insulating Screw, it consists of a serrated metal core coated during extrusion with a thermoplastic material, the core and plastic used depending upon the service to which the fastener is put. The composite rod is cut in an automatic screw machine, which forms accurate threads and a strong head. The torque applied by the screw driver or other tool is transmitted to the metal core, which furnishes most of the strength, while the coating gives the fastener its insulating and sealing properties. It is claimed that the plastic exterior does not chip or crack under torque. Standard sizes range from No. 8 to ½ inch with cellulose-acetate or with ethyl-cellulose insulation; No. 10 to ⅜ inch with polyethylene; and No. 8 to ⅜ inch with cellulose-acetate butyrate. Length, head style, and type of thread can be varied widely, and special



sizes coated to meet requirements are made to order. Plastic permits the use of color for purposes of differentiation, and it is said that plastic threads in combination with a metal nut tend to seize and form an effective lock, thus dispensing with lock washers or nuts. The new fastener is manufactured by the Forman Insulating Screw Corporation.

That fresh, clean smell that pervades the atmosphere after an electrical storm can be created on a small scale indoors by switching on a 4-watt lamp, according to the *General Electric Review*. The glass bulb is less than 1½ inches in diameter and operates on household current. It gives off ozone, which neutralizes many objectionable odors and has a mild germicidal effect. The first lamps produced are being built into clothes driers to give the wash that desirable sweet, clean smell, and also into refrigerators and vending machines. Engineers foresee their use in homes, offices, and working areas; in heating, ventilating and packaged air-condition-



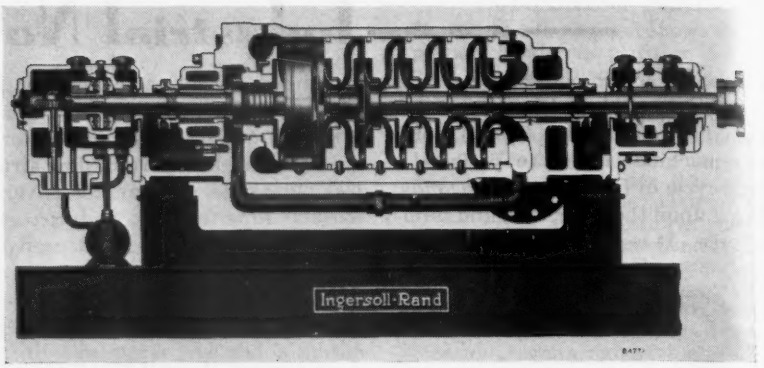
WORKS LIKE A SEESAW

Obsolete drop-hammer dies of steel, lead or Zemak that are too big to be put into a furnace for melting are being cut into pieces, as this picture shows, by a saw developed in the plant of The Glenn L. Martin Company by Jay M. Boyd, Jr. (right). Of the bandsaw type and provided with a counterbalance, it is easy to move around and operate by one man. Dies weighing approximately 5 tons each have been cut in two in 55 minutes, as against four to eight hours by the older methods.

ing units; as well as in small sanitary cabinets for medical, dental, barber, and beauty-shop supplies and instruments. One lamp is said to produce sufficient ozone to deodorize a space having a volume of 1000 cubic feet.

A highway striping machine, which includes a small air compressor to provide pressure for spraying the paint, is one of the most widely traveled vehicles in the State of Missouri. Until recently it did all the work itself, marking 7000 to 10,000 miles of hard-surfaced roads annually. In some prewar years, when 90 percent of the highways were of concrete construction, it made three complete trips. With the increasing trend towards black-top roads, more and more of the striping has to be done in the cooler seasons of the year, so the operation is now organized under ten state-highway divisions, each of which has its own marking equipment.

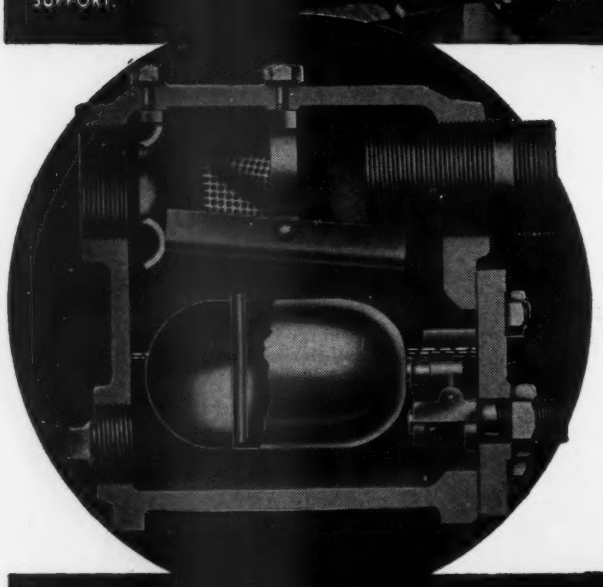
A line of multistage centrifugal pumps of new design for high-pressure service (up to 1200 psi.) has been announced by Ingersoll-Rand Company. Known as the Class HMTA, units are available in 3-, 4-, 5-, and 6-inch sizes with from three to nine stages, for a maximum temperature of 650°F., and with a capacity range of 125 to 1600 gpm. These pumps have two distinctive features: a horizontally split casing with a cylindrical, smooth bore and a Unit-Type rotor assembly composed of the shaft, impellers, and channel rings. The latter contain the multiple-volute or fluid passages, as well as the renewable wearing parts for each stage. Because there are no mating ring fits—no need for delicate alignment—the rotor assembly is readily removed or reinstalled in the casing, which is held together by a single row of bolts. According to the manufacturer, the multiple-volute design insures a balanced rotor that eliminates radial thrust under all operating conditions. Axial thrust is effectively counteracted by a hydraulic balancing drum which is accessible through the discharge stuffing box. Interstage sealing at all temperatures and pressures is provided by corrosion-resistant hydraulic-type piston rings which fit into machined grooves in the channel rings and form a tight metal-to-metal seal between the rings and the casing when the latter is bolted together. The HMTA's are said to be efficient, dependable, easy to maintain, and flexible in that the combination of impellers and channel rings on the original shaft can be changed to meet varying load conditions.



For cold, precision tube bending, Paul Machine Tool & Die Works recommends its improved Bend-Ex machine which is powered by an air cylinder and incorporates a newly developed die and clamping head that grips and bends automatically. These features give the Model A shown a maximum productive speed of 1000 bends an hour (1-inch 16-gauge steel tubing). In service, with the

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

stock on a mandrel, a ratchet arm and turret are set and air, normally at 80 psi., is admitted into the Hanna cylinder by a lever-controlled valve. Stock up to 10½ feet can be handled, and a single tube up to 1¼ inches outside diameter and of 16 to 18 gauge can be given as many as ten bends. Another model, Y, takes tubing up to 2 inches in diameter, 12 to 18 gauge. Distances between bends are set by adjustable stops, and dies for stock of varying diameter and for a maximum center-line radius of 9½ inches are readily interchangeable. Machines are suitable for bending round, square, and rectangular tubing, pipe, light angles, channels, solid bars, etc.

Clogged household drains can be blown clear with a so-called Drain Gun that is marketed by Handling Devices Company, Inc., of Boston, Mass. A small cartridge of compressed carbon-dioxide gas is screwed to the gun and punctured to admit gas to a chamber. When an attached gauge shows that the chamber pressure has reached 50 psi., a rubber-tipped plunger on the gun shaft is placed over the drain opening and pressed down. This opens a valve that admits gas to blow out the obstructions.

For protection against flying particles, American Optical Company has designed a new safety goggle for industrial use that is said to fit all faces and can be worn over most standard and prescription spectacles and goggles. Made of impact-resisting plastic in one piece, it features rolled edges and a plastic nosepiece for comfort, numerous perforations

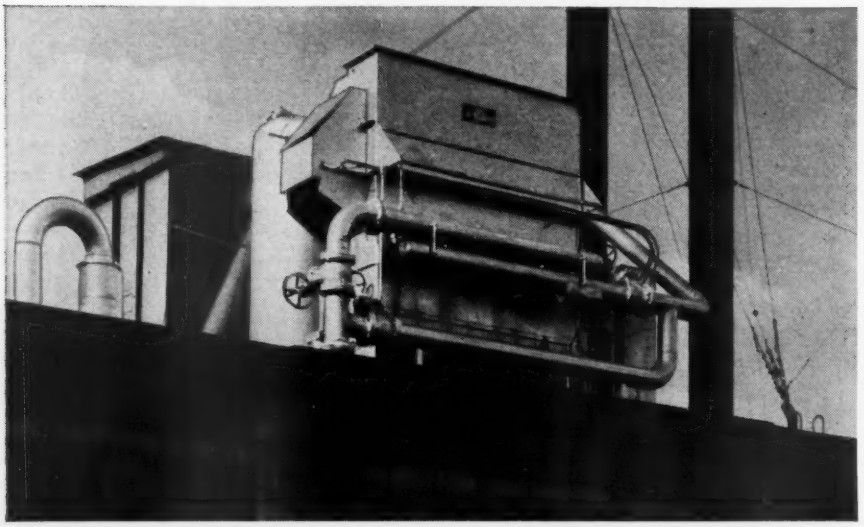
This Folder Will Help Answer Your Pipe Problems

To show where lightweight pipe can be used to best advantage in your field, Naylor has prepared this handy folder. It gives you helpful specifications on Naylor pipe, fittings, flanges and connections in concise form. Write today for your copy of Bulletin 507 . . . without obligation.

NAYLOR PIPE

Naylor Pipe Company, 1245 E. 92nd St., Chicago 19, Ill.
New York Office, 350 Madison Avenue, New York 17, N.Y.

Direct saving of cooling water expense returns to you the cost of a Niagara Aero After Cooler in less than two years.



How to Get Drier Compressed Air:

It prevents many troubles and saves much expense

● NIAGARA AERO AFTER COOLER cools compressed air or gas below the temperature of the surrounding atmosphere. Therefore you get no further condensation in your lines. You save much in repairs to pneumatic tools and equipment; you save much interruption to production; you save water damage in paint spraying, in air cleaning, in any process where compressed air comes in contact with your materials or parts in manufacturing (sand blasting, for example).

Niagara Aero After Cooler uses evaporative cooling, saving 95% of your cooling water consumption. This saving quickly returns the cost of the equipment to the owner or makes extra cooling water available for other processes.

The Niagara Aero After Cooler produces compressed air with 30% to 50% less moisture than by ordinary cooling methods. Other Niagara equipment provides bone-dry air for processes requiring it.

If you have an air problem or a cooling problem, a Niagara engineer probably has an answer that will improve your process or save you operating or maintenance expense.

Write for Bulletin 98

NIAGARA BLOWER COMPANY

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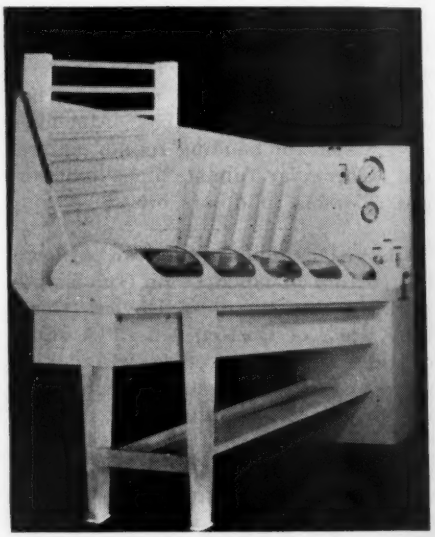
Experienced District Engineers in all Principal Cities

that insure adequate ventilation and minimize fogging, and an adjustable elastic headband. The goggle weighs but one ounce and comes in two styles: No. 479, which is clear, and No. 480, which is green.

Fast inspection and full protection for the operator are advantages claimed for a new air-operated machine designed by Sprague Engineering & Sales for the static testing of hose at any pressure up to 25,000 psi. A deep 10-foot-long inclined sump with drainboard serves as the test chamber and is covered with a roll-away top of Plexiglas. All components are housed in a cabinet and include a low- and a high-pressure boost pump and a hydraulic circuit with a 15-gallon oil reservoir. Air at 100 psi. pressure for the pumps can be taken from a shop air line and is controlled by a regulator which,

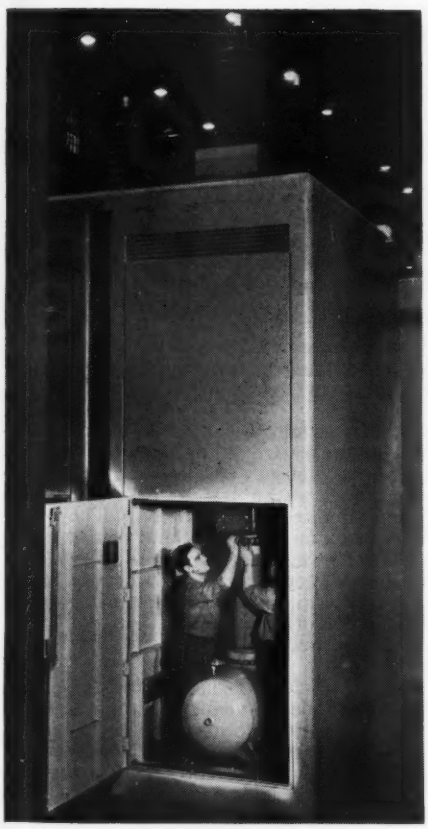


in turn, controls the output pressure of the machine. With hose lengths connected to manifold outlets in the hydraulic circuit, and with a selector valve set at low pressure, oil is forced into the hose, the contained air passing out through bleeder valves which close when the fluid enters. The selector is then turned to a predetermined high pressure and, upon completion of the test, is moved to the "off" position at which all built-up pressure is automatically released. Aircraft companies report that the equipment enables them to test twice as many hose in a given time as formerly.

For brazing stainless and other alloy steels, Wall-Colmonoy Corporation is marketing a powdered alloy under the trade name of Nicrobraz. Preparation for brazing is the same as in the case of a copper assembly. Before application, the joint, with a clearance which should not exceed 0.002 inch, is coated with Nicrobraz Cement. This holds the powder which, when heated to 2050°F., flows by capillary action. Tests indicate, reports the company, that the remelting point of the joint is 2600 degrees, or 550

degrees higher than the melting point of the alloy in its original form. As compared to the parent metal, the tensile strength of a butt-brazed superalloy specimen at room temperature is about 90 percent; at 2000 degrees, it is 99.8 percent. Joints show no loss in tensile strength and no sign of oxidation after exposure to 1600 degrees for 510 hours. They are resistant to sulphuric and organic acids, caustics, and strong alkalies.

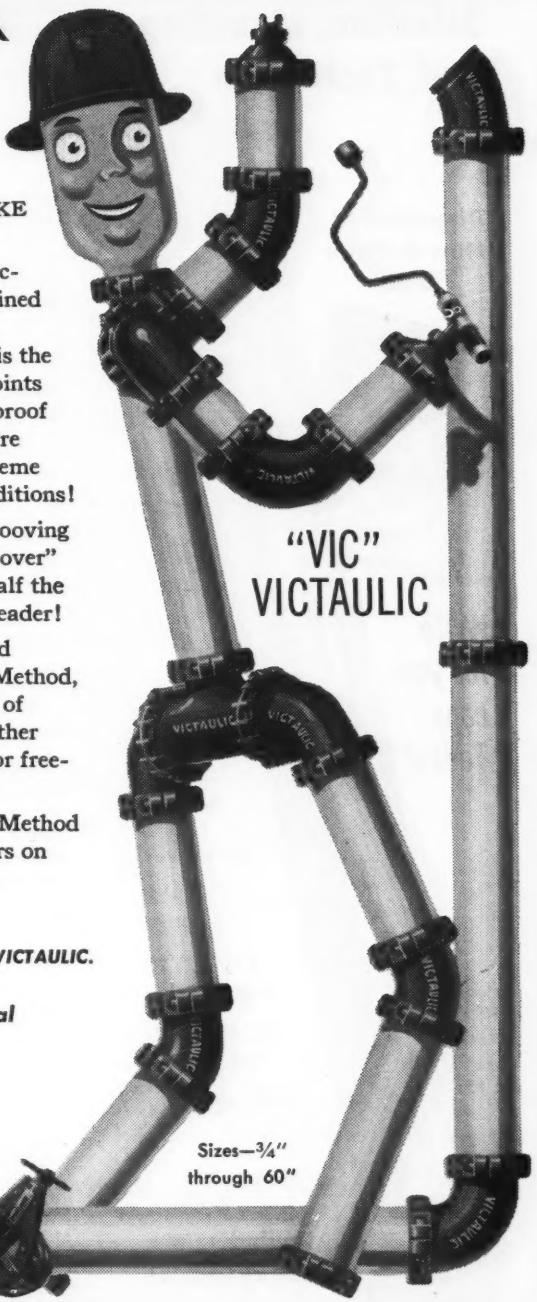
A ring of ratchet-like teeth on the underside of the head differentiates a new screw from the familiar type. When driven, the teeth bite into the head seat, and final tightening is said to produce a water- and oil-tight fit without the use of a lock washer. The screw, known as Spin-Lock, is carburized so teeth will not wear or flatten and so they will lock themselves in softer metal. It is made in four head styles: hexagon (from No. 4 to ¾-inch size), and flat, truss, and pan (from No. 4 to ⅜-inch size). Line includes Type A and B tapping screws.



HUGE ELECTRICAL SWITCH

Although they are full-sized, these workmen look like midgets as they assemble a compressed-air circuit breaker in the East Pittsburgh plant of Westinghouse Electric Corporation. Encased in a metal housing 20 feet high, the giant switch being built for Consolidated Edison Company of New York is designed to interrupt 3,500,000 kilovolt-amperes. Apparatus of this kind serves both to switch large blocks of power on and off and to protect power systems from damage caused by such natural forces as lightning.

RIGHT IN THE GROOVE



You just can't beat the COMPLETE Victaulic System for efficient piping construction... it's the EASIEST WAY TO MAKE ENDS MEET!

EASY, QUICK, SURE—that's the Victaulic Method. Pipe ends are joined in a jiffy by a simple two-bolt coupling. A speed or T-wrench is the only tool required. AND pipe joints will stay positive-locked, leak-proof with Victaulic Couplings. They're designed to stand up under extreme pressure, vacuum or strain conditions!

With the Victaulic Method, grooving pipe ends is a cinch..."Vic-Groover" grooves 'em automatically in half the time of a conventional pipe threader!

To give complete versatility and dependability to the Victaulic Method, Victaulic offers a complete line of Full-Flow Elbows, Tees, and other fittings all carefully designed for free-flowing efficiency.

"JOIN UP" with the Victaulic Method and save time, work, and dollars on construction and maintenance "right down the line!"

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Books and Industrial Literature

Although thousands of automobiles are used in sales work, the question of how they should be managed is seldom approached in a scientific way. At least, that is the contention of Samuel J. Lee, author of *Automotive Transportation in Industry*. He reports that variations of as much as two cents a mile in car-operating expenses are shown by two companies engaged in the same line of business and covering the same territories. Some concerns own their salesmen's cars, others lease them, and still others allow employees to drive their own. Where vehicles are company owned there is little uniformity regarding replacement. Some firms trade in every year, others every five years, and some replace cars on a mileage basis. One uses business coupes, another sedans, and a third has both types. Many other divergencies exist. Mr. Lee takes the stand that car administration should receive closer attention from management, and his book endeavors to give information that will be helpful in arriving at the best decisions. Containing 178 pages and 16 charts and forms, it is available from Fleet Management Corporation, 141 W. Jackson Boulevard, Chicago, Ill. Price, $5.00.

With nearly half of our population concentrated in 140 metropolitan districts and with industrial production of the nation having doubled since 1935, domestic and industrial wastes have outstripped treatment facilities and created a serious water-pollution problem. The facts and what can be done to remedy the situation are discussed in a booklet, *Clean Water is Everybody's Business*, published by the Federal Public Health Service, Washington, D.C. Single copies may be had without cost.

A folder on temperature and pressure regulators and desuperheaters, which contains an explanation of the principles of pilot-operated regulating valves, is offered by Spence Engineering Company, Inc., Walden, N. Y.

Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Ill., is distributing a data book and catalogue that lists its thermocouples and related equipment and gives essential data for selecting the proper equipment for a specific need. The publication is designated as Bulletin TC-8.

Micro-Photo Service Bureau, 4614 Prospect Avenue, Cleveland 3, Ohio, offers a 12-page booklet, *Facts and Figures on Microfilming Engineering Drawings*. It discusses the importance of safeguarding important company records and gives pertinent information on microfilming equipment, film storage, costs, etc.

Zincilate, a 1-coat anti-corrosion covering for protecting metal surfaces, is described in an 8-page technical bulletin available from Industrial Metal Protectives, Inc., 401 Homestead Avenue, Dayton 8, Ohio. The extraordinary resistance to corrosion that is claimed for this material is attributed to the fact that its zinc content is itself protected from atmospheric oxidation.

For services where packings or gaskets are in contact with chemicals, Garlock Packing Company offers them made of Teflon, a resin developed by du Pont. This material is unaffected by any acid and is highly resistant to all organic solvents and alkalies. Packings and gaskets made of it exhibit high mechanical strength and a low coefficient of friction when operating at any temperature from minus 90°F. to 500°F. Several types of Teflon packings and gaskets are described in a new bulletin, Form AD-143, available by addressing the company at Palmyra, N. Y.

A booklet that tells how stainless-steel parts should be prepared for hardening is offered by C.V. Scott & Son, Inc., Rock Island, Ill. The firm uses a specialized process, called Super Scottsonizing, to harden parts that have been machined to the exact finished sizes in which they will be utilized.

Bulletin No. 13, issued by Wilson Carbon Company, 60 E. 42nd Street, New York 17, N. Y., describes the Wilson process for depth hardening of large or small steel parts. Two compounds for this purpose are available, and it is asserted that their use makes conventional case hardening "as antiquated as the horse and buggy and as inadequate to modern tool requirements as wooden screwdrivers."

To meet the demands imposed by the progressive increase in sizes and capacities of earth and rock excavating equipment, John A. Roebling's Sons Company, Trenton 2, N. J., has developed wire ropes of special construction. They are described for the first time in a new catalogue, No. A-913, that is available upon request. It includes recommendations for rope for specific purposes and also a wire-rope code that has not been previously published.

Bulletin 50, of SPO, Incorporated, 6438 Grand Division Avenue, Cleveland 5, Ohio, describes pneumatic vibrators for use on foundry equipment; for dislodging and facilitating movement of powdered and granular materials in bins, hoppers, chutes, etc.; settling mixes in concrete block making machines; conducting fatigue tests, and other purposes. Accessory equipment such as control valves, fittings, and connectors, are also covered.

A new catalogue issued by Logansport Machine Company, Logansport, Ind., describes the firm's Air-Draulic cylinders, which have an air piston and a hydraulic piston mounted on a single rod. These cylinders are powered by air and regulated by oil. Also covered are the company's air cylinders, air regulator-filter-lubricator unit, and various air and hydraulic vises, presses, chucks, and other specialties. Ask for Catalogue 100, Section 3.

Bulletin B-200 of Miller Motor Company, 4027 N. Kedzie Avenue, Chicago 18, Ill., gives complete information on the firm's fluid pressure boosters. These devices, sometimes called intensifiers, operate on the differential piston principle whereby a hydraulic ram is driven by a cylinder of larger diameter that is energized either by air or hydraulic pressure. With the Miller line, practically any desired hydraulic output pressure up to 10,000 psi. can be obtained from ordinary plant air or hydraulic pressure. These boosters are suitable for such services as clamping, punching, shearing, stamping, crimping, welding, etc. Oftentimes their use in place of a pumping system will save space, weight in equipment, and eliminate the development of excessive heat. The bulletin discusses conditions that favor their adoption, describes the different types available, and furnishes the information required to select the proper one for a given application.